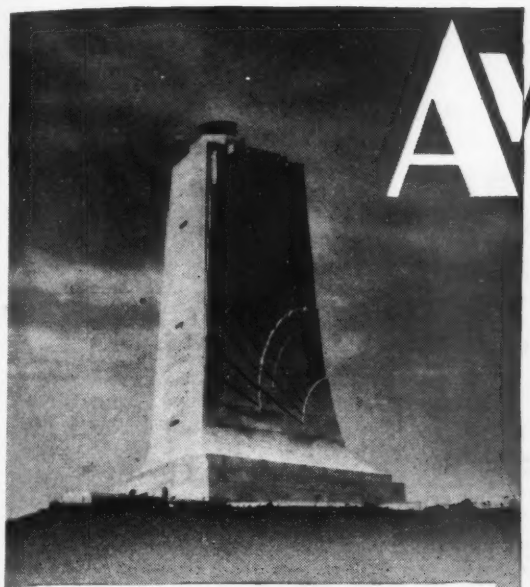

AVIATION

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McGRAW-HILL PUBLISHING CO., INC. Publication office 99-129 North Broadway, Albany, N. Y. Return postage guaranteed. Editorial and executive offices: 330 West 42nd Street, New York 18, N. Y. Branch offices: Chicago, 520 North Michigan Ave.; San Francisco, 68 Post Street; Aldwych House, Aldwych, London, W.C. 2; National Press Bldg., Washington; 16 South Broad St., Philadelphia; Hanna Bldg., Cleveland; 2980 Penobscot Bldg., Detroit; Continental Bldg., St. Louis; 1427 Statler Bldg., Boston; Rhodes-Haverty Bldg., Atlanta; 621 S. Hope, Los Angeles; 738-9 Oliver Bldg., Pittsburgh. JAMES H. McGRAW, Founder and Honorary Chairman; JAMES H. McGRAW, Jr., President; CURTIS W. McGRAW, Senior Vice President and Treasurer; HOWARD EHRLICH, Vice President (for business operations); WILLARD CHEVALIER, Vice President (for editorial operations); JOSEPH A. GERARDI, Secretary; J. E. BLACKBURN, Jr., Director of Circulation, Aviation, 330 W. 42nd Street, New York. Published monthly, price 50c a copy, 50c in Canada. Allow at least ten days for change of address. All communications about subscriptions should be addressed to Director of Circulation, 330 West 42nd Street, New York. Subscription rates—United States, Mexico and Central American Countries, $3.00 a year, $4.00 for two years, $5.00 for three years. Canada, $3.50 for one year, $5.00 for two years, $6.00 for three years, payable in Canadian currency at par. Great Britain and British Possessions, 30 shillings per year, 60 shillings for three years. All other countries, $5.00 a year, $10.00 for three years. Please indicate position and company connection on all subscription orders. Entered as second class matter September 3, 1936, at the Post Office, Albany, New York, under the Act of March 3, 1879. Volume 44, Number 10. Printed in U. S. A. Cable Address, "McGrawhill, New York." Member A.B.C.

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ARMY E NAVY

PRODUCT OF Bendix AVIATION CORPORATION

With more than a little pride we present another AVIATION *first*—the first complete design analysis of a jet propelled plane ever published anywhere. It's the Messerschmitt Me-262, the only jet fighter-bomber to see widespread combat action, and a thoroughly interesting craft it is. We've put it in print at the earliest possible moment, as is shown by the fact that one of the craft studied was still being prepared for test flight, and Managing Editor Jack Foster worked right along with the crew. Together, they found out a lot of things that would have otherwise been a long time coming to light. Part I, on the airframe, starts on page 115, and our November Part II will include just as thorough a job on the Junkers Jumo 004 axial flow gas turbine jet power plant.

Though the Me-262 was the only Nazi jet job to see widespread action, the Krauts had some plenty interesting designs coming along—much too close to production. One of the closest and most interesting was the P-60, a flying wing powered by two BMW 001 or Heinkel Hirth 011 jet engines. Complete details of three models of this radical design will be found on page 172, including one of "Pete" Bulban's engineering sketches.

But, as the man said, that's only the beginning, for data on five other craft are given. On page 108 are first photos and construction details of Douglas' new giant, the C-74 Globemaster, biggest of the military transports, and the DC-8, a truly radical design for airline operation. Then, on page 174 is the dope on Republic's new superspeed high altitude four-engine transport, the Rainbow. And directly opposite this are details of Howard Hughes' giant H-4 all-wood eight-engined flying boat, while on the page which follows are details of the Blackburn B-20, which features a huge retractable center float.

Pertinent to flying boats still to be designed, Ernie Stout, Convair's staff engineer in charge of hydrodynamics, has done another outstanding job of whipping fundamental problems, this time with his "Landing Analysis for Flying Boats and Seaplanes." This new series, which is loaded with just-released information, begins on page 137.

Though the impulse jet engine has a reputation as a fuel hog, it shouldn't yet be written off, for the improvements are coming fast. On page 136, for example, we give the first releasable data on a working model containing American developments which are reported to give it much better performance than predecessor types.

BILL STROHMEIER, just before completing some four years as instructor and Assistant Squadron Commander for American and French flying cadets at Hawthorne School, took time to write a very sound article on just how civilian student business can be increased by really heartening percentages —and with surprisingly little effort and time. The basic principles explained are applicable throughout the industry, from the manufacturer to the smallest fixed base operator. Incidentally, Bill's changed location, continuing right along with the industry by joining Charles H. Gale Associates, New York public relations firm, where he'll handle aeronautical accounts.

You hear plenty of complaints about the personal plane's lack of utility, a factor which, it's said, will definitely limit the market. These arguments sound pretty weak, though, when you read a story such as that on page 164, a case history of a hard-headed business man's use of not one, but a whole fleet of personal planes in—of all things —the steel business.

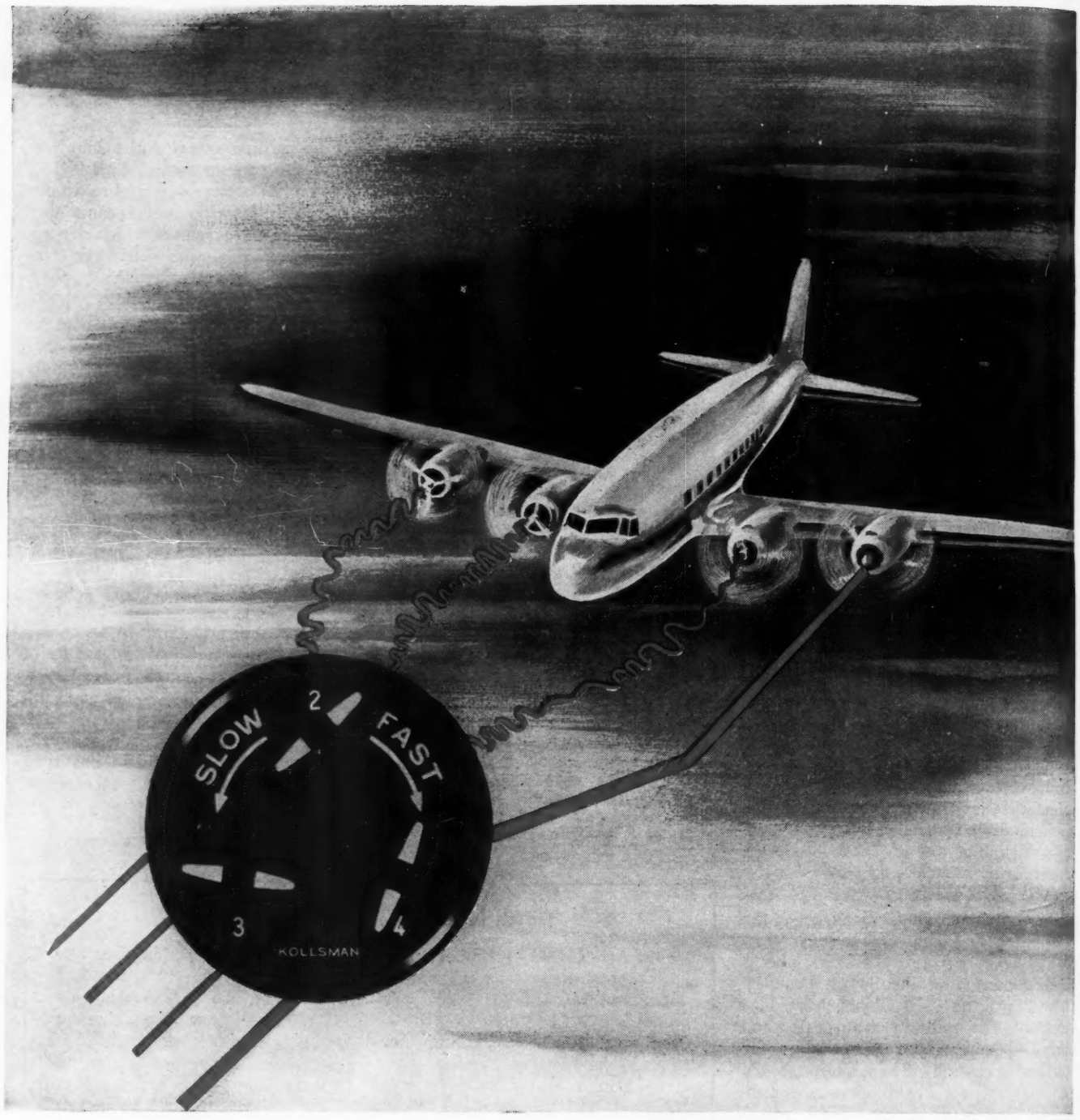
Mere mention of the word "bookkeeping" brings a heart-rending shudder to most fixed basers for they have plenty of other problems. But the most successful operators realize "you gotta know where the dough goes if you wanta stay in business." On page 166 you'll find how one man keeps track of every penny—easily and inexpensively, too—so that he still has time left to devote to the many other good business building ideas detailed in this article.

Down the Years in AVIATION'S Log

25 Yr. Ago (1920) — London-Paris airline completes first year's operation averaging 2.3 passengers per flight. . . . Handley-Page introduces slotted wing. . . . Sadi Lecointe wins Gordon Bennett Race at 184.8 mph., using Hisso-engined Nieupont, and Romanet, in a Spad comes in second. . . . German Mercedes supercharged engine develops constant power up to 13,000 ft. altitude. . . . Navy successfully uses interplane radio over 10-mi. range. . . . Pioneer introduces turn-and-pitch indicator. . . . French engineers build fabric-covered wood propellers.

15 Yr. Ago (1930) — TAT-Maddux and Western Air Express start first New York-California airmail under new name Transcontinental & Western Air, Inc. . . . Detroit announces 1931 International Air Show. . . . British Dirigible R-101 destroyed by fire while in flight. . . . Open cockpit types comprise 60% of total planes in use. . . . U. S. has 1,764 airports, of which 513 are municipal. . . . Average airline revenue is 85c. per plane-mile. . . . In National Air Tour 28 of 30 competing planes complete full 4,800 mi. sky-journey. . . . PAA South American routes now total 19,190 mi.

10 Yr. Ago (1935)—Waco builds fighter plane for Cuba. . . . Fairchild designs special floatplane freighter for use in north woods. . . . Polish LOT airline reports use of Bristol Pegasus engines on Douglas DC-2's. . . . Howard Hughes sets landplane record of 351.7 mph. in Hughes Special. . . . Laura Ingalls, flying Lockheed, betters women's transcontinental record with 13 hr. 34 min. coast-to-coast run. . . . UAL uses Boeing 247-D's exclusively on long distance flights. . . . Polish planes take first and second place in Gordon Bennett Race.



THE NEW KOLLSMAN FOUR-ENGINE SYNCHROSCOPE enables the pilot or flight engineer to bring all engines quickly to the same r.p.m. for the uniform power output required by economy and correct operating procedures. Designed at the request of AAF to cover military needs, these synchroscopes also have their application to transport aircraft, where they contribute to passenger comfort as well as to proper operation of the plane. The accuracy and dependability of these synchroscopes, together with their simplicity of operation, are characteristic of all Kollsman Aircraft Instruments.

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EDITORIAL

For Glamor, Easy Cash, and Sky-Gadding Stay OUT of This Business

YOU ARE A VETERAN of the recent World War. Perhaps you were a member of a Superfortress crew. Or a lone fighter pilot. Or one of the boys who stayed on the ground and helped perform the important miracle of maintenance and operation of our aircraft. Or maybe you were shot down early in the war and had lots of time for reflection in a prison camp.

In any case you have decided that you want to avail yourself of the great American privilege—to be in business for yourself. And the business you have selected is aviation.

If you have selected aviation on the basis of pure glamor it would be better if you skipped the whole thing and went back to your old job in the plumbing shop. The businesses that look most glamorous from the outside are usually the toughest when you get into them. If you don't believe it, try Hollywood for a while.

If you have selected aviation because it looks like easy money, just forget the whole thing. There are many easier ways to make a living. The local airport operator has about as much time for fishing as the local delicatessen store proprietor, who closes between 2 and 4 o'clock Sunday afternoons for his one leisurely meal of the week and uses half of this two-hour respite to clean up the store for the evening rush.

If you picked aviation just because you love to fly, try something else and do your flying as a hobby. The fellow who has to keep the business coming in must get out and find new customers—and you don't do that by flying around with a sky hook and yanking them out of the air.

AVIATION HAS ALL the headaches of any other business, plus a few extra ones thrown in. If you are willing to accept this truth, you are ready to learn what it is all about. It is a good idea to take the advice of those who have been through the mill, at least in the beginning. This experience will be available to you from the manufacturer who sells you the equipment. Study the methods of successful operators and follow them quite literally at first. Once you have made them work, it will be fitting time to try your own ideas.

Select your location on the basis of careful study of the business potential in the community, of accessibility to town, of weather conditions, cost of acquisition and maintenance, existing competition, possibility for expansion, and other pertinent factors. Then take immediate steps to provide decent accommodations for your customers. You don't have to invest a fortune to establish a clean, attractive, homelike place. Just ask yourself if it is the kind of place you and your family would enjoy visiting in a leisure hour, if you had one.

Next step is to let the public know you are there and what you have to offer. Encourage them to come out to your airport by every suitable device you can develop. Take part in the social, club, business, and even the religious activities of the community. Your stature in the community will do much to convince its members that yours is a sound and essential business.

BUT DON'T under any circumstances carry your promotion to the circus stage. That is the surest way to convince potential customers that your wares are not for them. Self preservation is still a most powerful instinct.

Air shows do have their place in bringing the public to the airport, but they must be set up to show how *useful* and not how dangerous airplanes can be. Let your customers go some other place to satisfy the insatiable human thirst for Roman holidays.

And if you are a pilot don't do what too many returning flyers have already done to swell the peacetime casualty lists. Don't assume that your lightplane has 1,000 hp. in the nose and go zooming your neighbor's house. If you do, it will make it harder for your heirs to stay in business.

There are many other factors in the formula for success in the aviation business. Adequate financial resources, realistic accounting practices, sound sales and service policies, careful and courteous handling of customers and prospects are some of the essentials. These ingredients, blended with plenty of energy and hard work, will not fail to bring success.

Leslie E. Neville

EDITOR

Besides meeting back-breaking production schedules, the aircraft producers did an outstanding job of putting their financial house in order during the war. Thus, despite post-VJ cutbacks, our analyst says—

Don't Sell THIS Industry Short

By RAYMOND L. HOADLEY, *Financial Editor, "Aviation"*

With all American industry hustling down the road to conversion from war to peacetime economy, it's time for the investor to take stock of the outlook for his aircraft holdings. He will find that the industry generally is more favorably situated to meet its problems than seemed possible as brief a time as a year ago.

Wall Street believed that if peace was to come this year it could not have been better timed, though this is not quite as true of aircraft as it is for other industries. However, there had been quite a substantial cut in aircraft procurement before V-J Day, and the industry had its 1945 year almost "made" earningwise.

A few companies like Bell and Consolidated Vultee were quite a jog down the reconversion path; others were much further on the way than a few months previous. Earnings for the first 7 mo. of 1945 for most companies were well ahead of a year ago, and reserves were being piled up at an accelerated rate.

The industry no longer was afraid to face reconversion.

Although contract settlement, surplus, and other problems connected with the termination of the war, have been big worries for aircraft officials, the thing that really haunted them was the fear of a quick plunge from "riches to rags" when the fighting was over. They constantly have had in mind the countermarch into neglect and near-oblivion that overtook the industry after World War I, when a war-weary nation refused to face the security problems of the future.

But it isn't turning out that way this time. The June trade officials were fearing that every last war contract for aircraft would be automatically cancelled on V-J Day under the War Mobilization and Reconversion Act. By the middle of August word came that government agencies were formulating plans involving the expenditure of more than $1,000,000,000 for aircraft experimental and development work in the first 12 mo. after V-J Day.

The industry had expected that the Army and Navy wouldn't let them down if they had the authority to do otherwise. But $500,000,000 was the most optimistic figure bandied about in aviation circles as the probable extent of immediate postwar government work.

So the industry starts down the postwar path geared to a probable government expenditure of around $1,000,000,000 for aircraft. To that must be added about $450,000,000 in orders for commercial transports. Douglas and Lockheed, between them, are estimated to have a backlog of around $300,000,000 in new transports, while Curtiss-Wright, Boeing, Consolidated Vultee, Republic, and Fairchild have undisclosed orders for similar craft.

Then there is the personal plane field, where predictions vary widely on postwar markets. Even before production was resumed, several million dollars in orders had been placed for the executive type of plane, such as Beech is building, on down to the single-place job.

Taylorcraft, less than a month after its sales representatives were first authorized to accept orders for future delivery, reported orders for 4,300 planes. The Stinson division of Consolidated Vultee has signed contracts with a western sales organization for $1,000,000 worth of private planes, and Republic has been reported to have conditional sales orders for 3,000 personal planes.

Though it may be too early to forecast far into the future on personnal planes, the above instances do indicate that the private plane makers will have plenty of orders for their initial output.

The export market may be a bit slow in developing, since this phase of the business has not received the advanced planning and development it deserves. Nevertheless, exports in the first year of peace should compare favorably with the $68,000,000 reported for 1938.

Dutch and Swedish airlines are counted on to want new equipment, and there should also be others who won't be satisfied with war surplus. And the Latin American nations should begin to import planes in sizable quantities soon. Moreover, India and other British Empire nations want planes just as soon as England will convert their sterling into dollars.

Thus the preliminary prospects are that the aircraft industry enters its reconversion phase with a probable backlog of $1,500,000,000. While this is slightly less than 10 percent of the industry's peak $16,000,000,000 war production rate last year, it compares more than favorably with a prewar level of only $200,000,000.

In fact this potential postwar output may be more than can be handled readily in privately-owned plants. It is true that the industry has expanded from a $114,000,000 plant in 1939 to a $3,458,000,000 plant, but only $293,000,000 of this expansion was financed by the aircraft companies themselves. The rest represents government units.

Some companies already have, or expect to acquire, certain of these government properties; a few of the

others will continue under lease. And it is important to note here that the plant expansion done by the aircraft industry during the war was accomplished largely without increasing capital structures. Only in a small minority of cases do companies have larger amounts of stocks and bonds outstanding than they had in 1940.

Another early anxiety has been pretty well dissipated. Practically the entire automobile industry, among others, has been engaged in aircraft war production and done a good job of it, all things considered. But now the automotive industry generally is forgetting about aviation and going back into the business of making as many motor cars as it can. Even the companies who announced they would continue in the plane field, like Ford, have changed their minds on second thought.

General Motors, besides continuing its prewar Allison engine division, of course plans to do a certain amount of aviation research at its projected research center. Packard, which had no idea of staying in aviation from the first, now has been asked by the Navy to take on an aircraft engine research project. These are the only two exceptions.

The aircraft investor has several measuring rods with which to test an individual company's prospects. First and foremost is the organization's reputation with military procurement officers, since it's axiomatic that the industry will be basically dependent on government buying for years to come. Equally important is a company's engineering skill and future planning. Look through a company's annual report for the last couple of years and you will get a good idea of how its officials view the future. And, last but not least, is the financial strength that companies have accumulated in the last 5 yr.

Wall Street analysts are pointing out that many investors have failed to comprehend fully the financial improvement that has taken place in the aircraft industry during the war. Take Glenn L. Martin Co., as an example. On June 30 the stock market appraised this company at $32,050,073, or $28.50 a share, compared with a market valuation of $52,263,903 when the stock was selling at a peak of $47.75 in 1940.

While the stock market appraisal of the company was declining by $20,213,830, Martin was increasing its working capital by $8,715,630, from $11,851,696 on June 30, 1940 to $20,567,326 on June 30, 1945. And, in addition, Martin had set aside, during these 5 yr., $29,500,000 in funded reserves for contingencies, renegotiation, postwar expenses, and adjustments. During that 5 yr. consolidated earned surplus grew from $9,592,122 to $20,316,250 and book value from $20 to $30 a share, exclusive of reserves. The improvement in the Martin financial position is fairly typical of that of the major aircraft companies.

For example, the net working capital of twelve of the larger plane makers, as pointed out by analysts of the brokerage firm of W. E. Hutton & Co., jumped from $61,678,000 at the end of 1938 to $387,810,000 at the close of 1944. When excess profits tax refunds and cash reserves are added, these companies showed a gain of $428,120,000 in net liquid assets. Against this gain of $428,120,000, the market value of stocks of these companies increased only $12,385,000.

The accompanying table (reproduced from a study on jet propulsion just completed by Reynolds & Co.) clearly illustrates the current position of many of the leading airframe and engine builders, giving comparisons with their respective positions just before the war.

Conclusion would seem to be that the industry, generally speaking, is in good shape financially for the transition period. What can happen to this financial position in the next 2 yr. is, of course, another matter. That is where management comes in as well as a company's particular niche in the industry. It would be no trick at all for a company to lose $5,000,000 or more

(*Turn to page* 246)

Corporation Period Ended, 1944	Bell Dec. 31	Boeing Dec. 31	Consol. Vultee(g) Nov. 30	Curtiss-Wright Dec. 31	Douglas Nov. 30	Grumman Dec. 31	Lockheed Dec. 31	Martin Dec. 31	North American Sept. 30	Northrop July 31	Republic Dec. 31	United Aircraft Dec. 31
CAPITALIZATION:												
Funded Debt	NO FUNDED DEBT											
Preferred Stock (Par Value)	$ 0	$ 0	$3,973,965	$46,348,080(e)	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$25,886,500
Common Shares	394,240	1,082,454	1,385,945	7,432,039	600,000	508,060	1,075,889	1,124,564	3,435,033	403,680	982,406	2,656,701
COMMON SHARE DATA BASED ON ABOVE CAPITALIZATION:												
Assets:												
Current Assets	$222.57	$ 93.88	$217.46	$ 88.88	$205.03	$157.15(a)	$130.54	$190.76(a)	$ 36.41	$ 62.40	$112.63	$ 59.02
Current Liabilities	197.45	68.44	191.70	85.23	122.24	129.52	128.44	161.22	47.17	56.51	104.62	33.38
Net Current Assets	25.12	25.44	25.76	3.65	82.79	27.63	22.10	29.54	9.24	5.89	8.01	25.64
Excess Profits Tax Rebate	7.71	7.42	1.51	3.44	11.64	10.78	5.36	7.78	1.98	1.44	3.39	1.58
Sub-Total	32.83	32.86	27.27	7.09	94.43	38.41	27.46	37.32	11.19	7.33	11.40	27.22
Plant and Equipment — Emergency Facilities, Net	—	— (b)	8.33	1.03	6.34	—(b)	11.08	2.66	—	2.95	—	0.01(b)
Plant and Equipment — Regular Facilities, Net	4.15	6.73	4.61	1.35	5.25	1.68	3.65	5.43	0.48	1.47	0.67	4.42
Other Assets, Less Other Liabilities except Post-War Reserves	1.45	0.75	0.62	1.86(d)	5.13	0.43	5.64	3.32	0.47	1.52	0.80(d)	0.42(d)
Book Value, Including Post-War Reserves	$38.43	$ 40.34	$ 40.83	$ 7.61	$111.15	$ 40.52	$ 47.83	$ 48.73	$ 12.14	$ 13.27	$ 11.27	$ 31.23
Book Value, Year end 1938	6.70	9.84	3.10(j)	1.95(d)	20.53	3.16	4.47	12.86	2.20	—	1.98(d)	10.49
MARKET PRICE, August 24, 1945	20	23½	21⅜	6	84	34¾	28⅝	25⅛	10¾	7½	9	26⅜
August 24, 1939	16	17½	8¼(j)	4⅜	58½	13	19⅜	27⅛	13⅞	—	2⅛	32½
SALES (Millions)												
1944	$317.5	$ 608.1	$960.0	$1,716.9	$1,061.4	$ 323.7	$ 602.5	$ 533.4	$ 718.0	$ 88.0	$ 369.6	$ 743.5
1941	46.4	93.9	129.6(h)	373.1	180.9	21.9	144.7	67.2	60.9(c)	3.4	10.8	307.2
1940	5.2	19.4	15.0	138.7	61.0	8.8	44.9	30.7	36.9	—	10.3	126.1
1939	0.5	11.8	3.6	48.7	27.9	4.5	33.3	24.2	27.6	—	0.9	51.2
NET INCOME (Per Share) (f)												
1944	$8.01	$4.86	$8.80	$1.62	$12.81	$9.73	$4.20	$4.37	$2.44	$1.50	$3.76	$5.37
1941	5.00	5.65	7.87(h)	3.15	30.25	2.10	6.14	5.13	1.77(c)	2.10(d)	0.80	5.81
1940	0.72	0.35	1.12	1.81	18.05	2.79	2.94	4.82	2.06	—	0.94	5.33
1939	0.02	3.03(d)	0.64	0.39	4.81	1.76	2.91	3.66	2.06	—	0.33(d)	3.04
DIVIDENDS (Per Share)												
1944	$1.00	$2.00	$2.00	$0.75	$5.00	$1.50	$2.00	$3.00	$1.25	$0.25	$0.50	$3.00
1941	2.00	—	3.00	1.00	5.00	1.50	2.00	3.00	2.00	—	—	4.00
1940	—	—	1.00	0.50	5.00	1.25	1.50	2.00	1.25	—	—	3.50
1939	—	—	—	—	3.00	1.05	1.00	1.00	1.40	—	—	2.00

(a) Includes U. S. certificates earmarked for reserves
(b) Allows for deductions of notes due against plant contracts
(c) Nine months to September 30, 1941, prior years ended December 31
(d) Deficit
(e) Class A common stock
(f) After deducting reserves
(g) Includes Vultee Aircraft for 1940 and 1941
(h) 1941 and prior years ended December 31
(j) Adjusted to reflect 100% stock dividend

Courtesy Reynolds & Co.

First Douglas C-74 Globemaster, military version of DC-7, rolls from plant at Long Beach, Calif. Plane's height of 43 ft. 9 in. necessitated rolling nose wheel over specially-built platform to swing fin beneath door top. Both pilot and co-pilot have individual "bug eye" canopies to give greater vision.

TWO NEW DOUGLAS TRANSPORTS SPARK AIR-CARRIER RACE

C-74 Globemaster is 155,000-lb. 125-troop long-range carrier with unique quick-loading devices . . . And new DC-8 presents unorthodox design features aiming for speedier, more economical domestic service.

TWO NEW ENTRIES covering widely separated segments of the transport field have just been introduced by Douglas Aircraft Co.—the C-74 Globemaster, a 155,000-lb. trans-oceanic military craft, and the DC-8, a 39,500-lb. passenger liner of radical design.

Globemaster is a low wing monoplane of 173 ft. 3-in. span, 124 ft. 1½-in. length, and 43 ft. 9-in. height, having a total fuel capacity of 11,000 gal. giving a maximum range of 7,800 mi. at 275 mph. It has a useful load of more than 30 tons. Military version of the craft will transport 125 fully equipped troops or 115 litters.

Douglas engineers consider the first plane a production model and not a prototype or experimental craft, for even before it made its first flight with Ben O. Howard at the controls,

Main cabin is 75-ft. long and 11-ft.-plus wide, with maximum usable height of 8 ft. 6 in. Military version has stationary crane at forward end and two traveling cranes (shown here) capable of lifting jeep on elevator. Latter becomes part of cabin floor. As military transport, craft has capacity of 125 fully equipped troops; as evacuation plane, capacity is 115 litters.

the second plane had been moved up the production line.

Semi-monocoque flush-riveted fuselage has a circular cross section with a maximum outside dia. of 13 ft. 2 in., utilizing Z- and channel-shaped frames and hat-shaped stringers. Pilot's compartment has individual "bug eye" enclosures for pilot and co-pilot to give maximum vision.

There are five main fuselage sections: Pilots'; crew, and relief crew compartments; main cabin; and belly cargo compartments. The relief crew's quarters, located just below the crew's compartment, will sleep six.

Main cabin is some 75 ft. long, and over 11 ft. wide, with approximately 875 sq. ft. of floor space and maximum usable height of 8½ ft. Flooring, of .072 aluminum sheet reinforced by magnesium I-beams, is covered by a 20-in. grid pattern of cargo tie-down rings, and is designed for maximum load of 200 lb. per sq. ft., or 60 lb. per in. of cabin length.

Cargo can be loaded simultaneously through a side door just ahead of the wing and through a bottom well aft of the wing. Two types of built-in loading cranes are provided: A stationary hoist of 4,500-lb. capacity at the side cargo door and two traveling cranes of 8,000-lb. capacity each. The traveling cranes operate the elevator (which becomes part of the main cabin floor) and distribute cargo via 50-ft. overhead rails inside the cabin. Electric power for the cranes is provided by an auxiliary engine (located in the right engine nacelle) which also supplies starting and emergency power.

A new Douglas-developed semi-laminar flow section was developed for the wing, which has a two-spar center section supporting the engine nacelles and integral fuel tanks. Leading edge, of double skin construction to provide for thermal anti-icing, contains crawlways from the fuselage to the engine nacelles to permit inspection and repair of power plants and to give access to main landing gear emergency release control.

Another new Douglas development is the combination aileron and flap arrangement which keeps landing speeds below 95 mph. Inboard flaps, across the bottom of the fuselage, are conventional split type. From there to the aileron position they are combination flap and vane, and at the aileron positions are combination of flap, vane, and aileron. The two outboard sections give a double slot effect. Hinges —eight to a side—are mounted externally, but the weight saving is said to compensate for added drag.

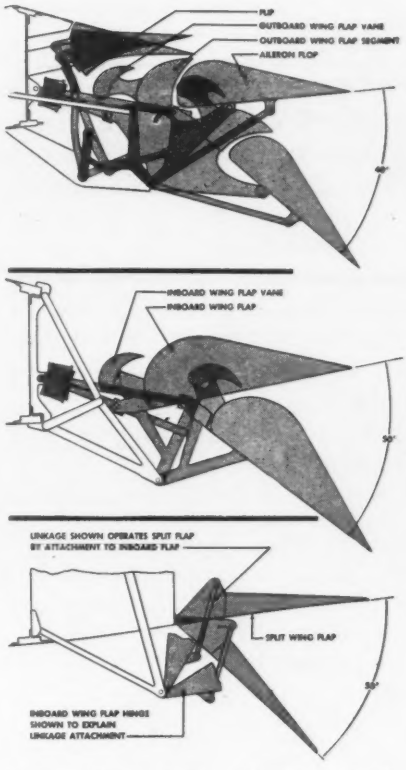
All-metal full-cantilever stabilizers have double skin leading edges for thermal anti-icing, and metal-framed aerodynamic-and-mass balanced elevators are fabric covered. Similar construction is used in fin and rudder.

Landing gear employs dual main wheels with 65-in. dia. tires which have a tread of 34 ft. 2 in., and dual nose wheels (with 44-in. tires) mounted on a common axle. All wheels retract forward and are so arranged that gravity will normally suffice for lowering and locking. Emergency hydraulic power is, however, available. The nose wheel is equipped with a hydraulically-powered steering system, with the pilot's steering wheel independent of other controls.

In addition to hydraulic brakes designed to stop the craft, fully loaded, from 85 mph. in 415 ft., an emergency airbrake system is provided.

The Globemaster is powered by four 3,000 hp.-plus R-4360 Pratt & Whitney Wasp Majors, turning four-blade Curtiss electric reversible propellers to reduce landing roll. It is impossible to reverse the propellers unless the craft is on the ground. Quickly demountable power packages are interchangeable, and they contain all power plant elements except the oil tank, which is set aft of the firewall.

All fluid lines have self-sealing couplings; control cables have quickly de-

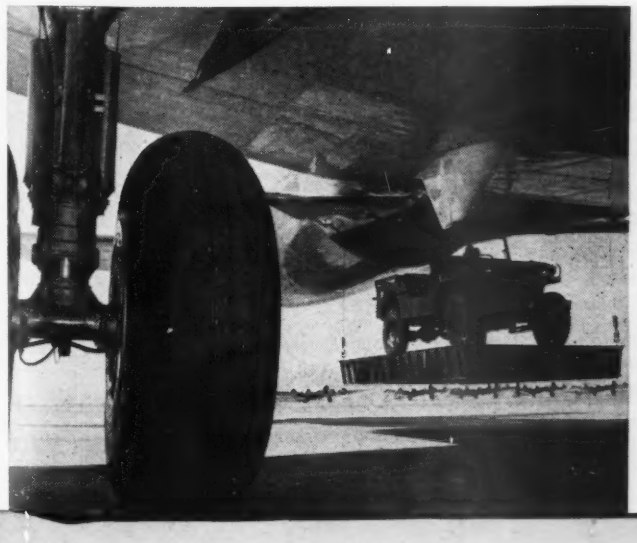

FLAP
OUTBOARD WING FLAP VANE
OUTBOARD WING FLAP SEGMENT
AILERON FLAP
INBOARD WING FLAP VANE
INBOARD WING FLAP
LINKAGE SHOWN OPERATES SPLIT FLAP BY ATTACHMENT TO INBOARD FLAP
SPLIT WING FLAP
INBOARD WING FLAP HINGE SHOWN TO EXPLAIN LINKAGE ATTACHMENT

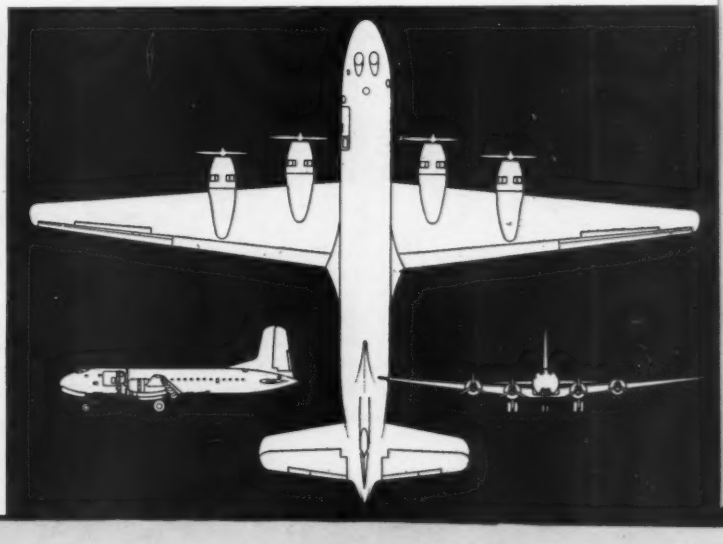
Cross sectional sketches showing operation of combination aileron and full-span flaps. At top is shown operation of outboard flap and aileron section; at center is seen inboard wing flap section, and sketch above depicts split type flap extending across bottom of fuselage.

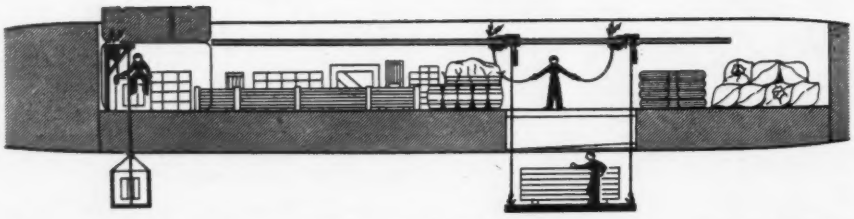
C-74 Specifications and Data

Span	173 ft. 3 in.
Length	124 ft. 2 in.
Height	43 ft. 9 in.
Useful load	Over 60,000 lb.
Gross wt. (overload)	155,000 lb.
Fuel capacity	11,000 gal.
Maximum range	7,800 mi.
Maximum speed	Over 300 mph.
Cruising speed	275 mph.
Main cabin capacity	6,500 cu. ft.
Belly cargo compartment capacity	615 cu. ft.
Power	Four 3,000-hp. R-4360 Pratt & Whitney Wasp Majors

Main landing gear employs dual wheels with 65-in. tires. Retraction is by hydraulic system operating at 3,000 psi., reduced automatically in flight to 250 psi. to reduce wear. Jeep at right is being lifted on cabin floor-elevator by the two traveling cranes, which can distribute load inside cabin. These units, combined with special truss type hoisting frame mounted on engine nacelle, can be employed for quick engine change. Right, three-view of C-74.



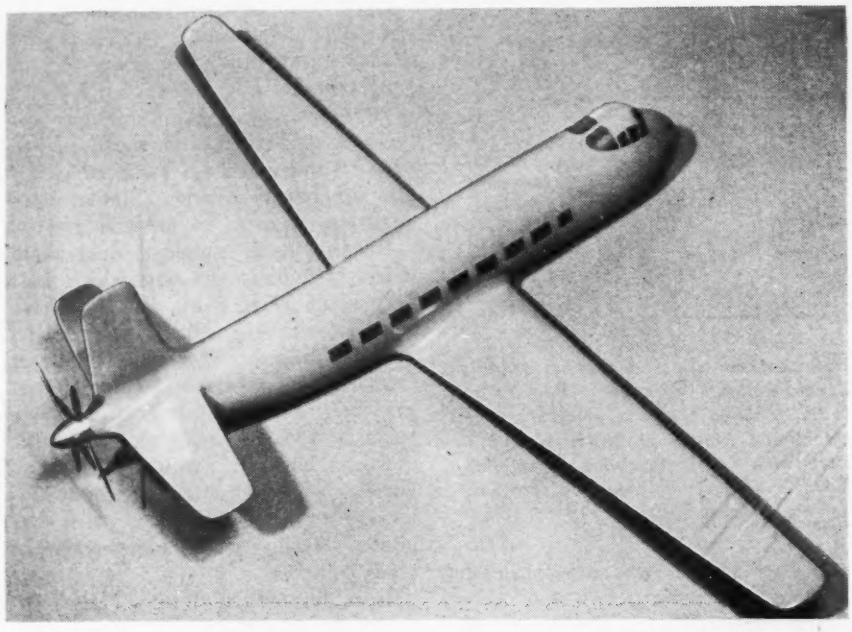




Diagrammatic layout showing cargo loading facilities. Stationary crane at side door just ahead of wing has 4,500-lb. capacity; twin traveling cranes operating on 50-ft. rails inside cabin have capacity of 8,000 lb. each.

DC-8 Specifications and Data

Span	110 ft. 2 in.
Length	77 ft. 10 in.
Height	25 ft. 9½ in.
Wing area	1,104 sq. ft.
Gross & max. landing wt.	39,500 lb.
Wt. empty	23,915 lb.
Useful load	15,585 lb.
Max. cruising speed, 10,000 ft.	270 mph.
Max. 2-engine climb, S.L.	1,030 fpm.
Max. 2-engine club, 10,000 ft.	840 fpm.
Max. 1-engine climb, S.L.	285 fpm.
Max. 1-engine climb, 10,000 ft.	145 fpm.
Block-to-block speed, 300-mi. range, 10 mph. headwind	223 mph.
Direct op. cost per plane mi.	41.6¢
Direct op. cost, 200 lb. mi.	0.695¢



Scale model of Douglas DC-8, 38-48 passenger liner powered by two V-1710 Allisons set in fuselage just below pilots' "double bubble" cockpit and driving contra-rotating Curtiss propeller via 60-ft. shafts running under passenger cabin. Though designed as replacement for DC-3, cabin pressurization has been provided for.

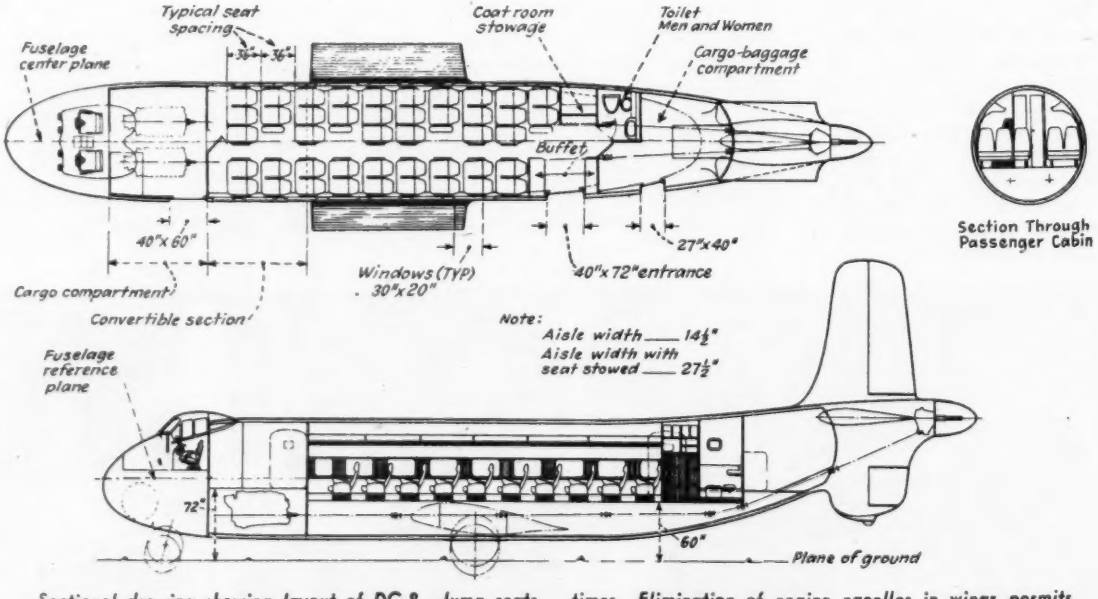
tachable latches, with one end of the cables attaching to the firewall; and all electric conduits have quick-disconnect plugs. Cowling is entirely supported from the nacelle structure, with the upper section containing the air induction system, the lower the oil cooler ducts. The four side panels are quickly detachable for servicing.

Electrically operated power plant units include cowl flaps, oil cooler exit flaps, carburetor air filters, fuel booster pumps, oil transfer, auxiliary power plant throttle control, and air cooling scoop.

Current military orders are scheduled for completion by July, 1946, and Douglas officials report 26 commercial-version planes to cost $40,000,000 have been ordered by airlines. No predictions would be made as to when the commercial production would begin.

The initial test flight of 1 hr. 35 min. was made following a ground test run lasting but 10 min., and the craft took off after a run that was noticeably shorter than those required

(*Continued on page 254*)



Sectional drawing showing layout of DC-8. Jump seats permit varying passenger loads to care for peak operating periods, and movable bulkhead permits varying passenger-cargo loads to give maximum payload at all times. Elimination of engine nacelles in wings permits short landing gear and puts major elements of craft close enough to ground for servicing and loading without use of platforms and other cumbersome equipment.

KEEP THOSE STUDENTS COMING BACK FOR MORE

By WILLIAM D. STROHMEIER

Salesmanship can do it, as shown by these tested and proven methods which develop a surprisingly large volume of business for the little work involved.

IF EVERY STUDENT who started flying lessons kept coming back for more—even if only to solo—most operators would have all the student business they need. The mortality (drop-out) rate among beginners, as any flying school manager can tell you, is terrific.

If they checked their records they'd find that this loss comes mainly after a student has had about three or four hours of dual. At least that's the conclusion reached by W. Ted Gannaway, Director of Sales for Hawthorne Flying Service, which operates several bases in the Carolinas.

Gannaway, a sales specialist before joining Hawthorne and a veteran in the automotive sales business, has put statistics to work in analyzing Hawthorne's student business and, by instituting a system of "frequency control" and follow-up, he has done a great deal to overcome this loss of future student business.

Conclusions on the student instruction business reached by Gannaway after studying operations at the six Hawthorne bases include:

1. A student will continue his flying to a greater certainty if he takes two or more lessons a week. (A student's enthusiasm slacks off dangerously if he allows more than a week to go by between lessons.)

2. A high point in loss of students comes after the initial lesson. (This is explained in part by the fact that many try a lesson out of curiosity's sake and have no real intention of soloing.)

3. A few simple follow-up procedures, mainly on the part of instructors, aimed at making a definite appointment for the next flight, helps bring customers back for more where normally they'd fail to show up again.

4. A definite statistical control—irksome as it may seem to instructors—is necessary to keep track of how student business is running.

While many of Hawthorne's statistics are lopsided because a high percentage of transient military personnel make up the company's student business, Gannaway found that the general figures and percentages given below are typical of an operation where no definite follow-up procedure is pursued. He calculates that over a period of 2 mo. these percentages will apply, broadly speaking:

Some 32% of student business will be done with those who take only one lesson and never come back, 24% will be students taking only two lessons; 21% will take three to four lessons; and 23% will take over six lessons—usually those who actually solo. Thus it can be seen that if an operator could solo every student taking an initial lesson he'd nearly quadruple the volume of student business; or if only half the students who start continued, the volume would be doubled.

When it is realized that the major

selling job has been accomplished by the mere fact that a student came out to the field to take a lesson, it would seem that a selling program to build up the "repeat" business would require less effort than getting the initial contact. Gannaway's system at Hawthorne, while following old established principles of sound sales follow-up, introduces a clean, fresh approach to the student flying business.

First off, all persons who have been contacted are recorded, generally at the time of interview, on a normal prospect card. Two colors are used to distinguish the type of prospect. White card is filed if the prospect actually comes to the field and takes a ride or demonstration lesson or inquires about flying lessons. A yellow card is filed for prospects contacted downtown or solicited. Obviously, white-card prospects are potentially better, since they've had enough interest in flying to come to the airport.

The card lists all pertinent data, such as address, occupation, firm, etc., and, where possible, the prospect's birthday is noted in order that a card may be sent as a reminder of Hawthorne. The nature of the student's interest is indicated by a code on the card consisting of five blank squares. By checking one or more squares in proper order, the interviewer indicates whether the prospect is interested in student flying, solo flying, whether he's a service man or woman, a private pilot, or commercial pilot.

The Flight Sales Manager makes periodic checks on the status of these prospects and follows up by personal letter or phone those who have not done any flying. But the main follow-up is accomplished by means of information contained on the "Student Flight Record" maintained at the Operations Counter.

The latter comprises standard 8½ x 11-in. sheets and contain on top much of the information on the Prospect Card. In the first two columns below the instructors enter dates of all flights, amount of time given on each lesson, and total accumulated time. In the third column, the instructor checks the student's "Flight Status", of which there are three categories—dual only, dual and some solo, or full solo instruction.

A final column leaves room for instructors' remarks. Thus if a student wants to fly and his regular instructor is busy, another instructor may refer quickly to the Flight Record and see his status. For students qualified to fly solo without a check-out, the dispatcher may also refer to this sheet. If the student's last flight was within two weeks and was checked as a solo flight by the instructor, the student may be quickly released with a solo airplane.

No 201 SD-5—5M Boineau & Co.

Hawthorne
LINESMAN AUTHORIZATION

Please permit M.....
to have for solo flight a J-3 ☐ J-5 ☐

.....☐ fully serviced.....

Time Out - - - - - .....

In - - - - - .....

Total - - - - - .....

Plane NC..... Inst.....

Linesman .....

Important Notice: This authorization to be returned to the office after flight. All flights in accordance with the Civil Air Regulations. Acrobatics prohibited.

RESTRICTED AREAS

This is a HAWTHORNE Service.

This Linesman Authorization card greatly simplifies and speeds handling of solo students while still keeping accurate records. It's part of the businesslike, keep-tab system which has proved so successful in boosting student business.

In this case the Dispatcher gives the student a Linesman Authorization ticket which authorizes the linesman to release such and such an airplane to the student. The linesman keeps the ticket while the student flies, noting the time of departure and return. At the end of the flight the student brings the ticket back to the dispatcher for billing.

In addition to the usefulness of the Student Flight Record sheets, which are filed alphabetically in a loose-leaf book, the records serve an even more important purpose in showing the frequency with which a student does his flying.

Hawthorne figures a flight-week from the start of flying Sunday morning until the end of flying Saturday evening. Each time a student flies during a weekly period, his instructor attaches an ordinary paper clip to the Flight Record. At the end of the week, a quick survey of the "repeat" business can be made by noting the number of paper clips on each student's sheet. Of course, those sheets bearing no clips indicate students who haven't flown that week. A survey of the records of this type of students produced the conclusion that students soon lose interest in their flying if they wait more than a week between lessons.

Here's how Hawthorne goes about increasing the frequency of a student's flight lessons: First, instructors have been taught not to end a lesson with the usual, "Well, you're getting along okay. Come on back again soon for another lesson." Instead they casually ask, just before the student leaves, "Can I put you down for an appointment at this same time day after tomorrow?" (It has been found that suggesting an appointment for the following day is too soon.) The psychology of this works well, since the student is at least professing enthusiasm for his training and if he's pinned down to a definite appointment will accept the suggestion rather than hem and haw around with reasons why he thinks he'll be on the golf links instead. This procedure alone has shown a definite improvement in Hawthorne's repeat business.

For student's whose cards show no clips during the week, the telephone or a postcard works well. Each instructor looks over the sheets and when he finds a slow student he drops him a postcard which might go something like this: "Dear Joe: We missed you last week for your flying lesson. Certainly hope you'll be out this week. How about Thursday afternoon? Give me a call." The cards are personalized as much as possible and always written in longhand by the instructor.

Results have been surprisingly effective. At Hawthorne's Columbia, S. C., base, where this system was first introduced, repeat business has picked up by more than 20 percent. Indeed, the reaction from the students has been even more surprising—they are very apologetic about not being out sooner and go to great length explaining their absence.

At times, the post-card system is supplemented by telephone calls, which have an equally productive effect. For students who don't respond to these preliminary calls or cards, follow-up letters are sent, plus personal calls by the Sales Manager. These calls serve not only to get the students back flying but also to keep base managers alert as to possible reasons why Dr. Jones, after starting his flying lessons, had given them up.

Much of this work, which takes surprisingly little time, is done when there's no flying because of bad weather. The data as to who should get a follow-up card is readily available at all times from the Flight Record sheets.

It has been found that one of the main reasons for a high mortality rate after the first lesson is an unsalesmanlike treatment of that initial and highly important flight. Prospects with little or no previous air experience have been flown when the air was too rough, perhaps the instructor wasn't friendly

enough or didn't display a genuine interest in selling the prospect on the pleasure and ease of flying, or failed to show convincingly that modern airplanes practically fly by themselves.

Oddly enough, one of the biggest single factors is steep turns in the traffic pattern, particularly the final turn into the approach. It's understandable how this could alarm a newcomer. The instructor chops the throttle a little too abruptly—which always surprises a non-pilot—and then rocks the ship over into a steep bank out of the base leg. The new student associates a spin or lack of control with the seemingly dead engine and when the sharp turn occurs, he's convinced something's wrong. Little but important details such as making that final turn a little more gently have been introduced into demonstration lessons.

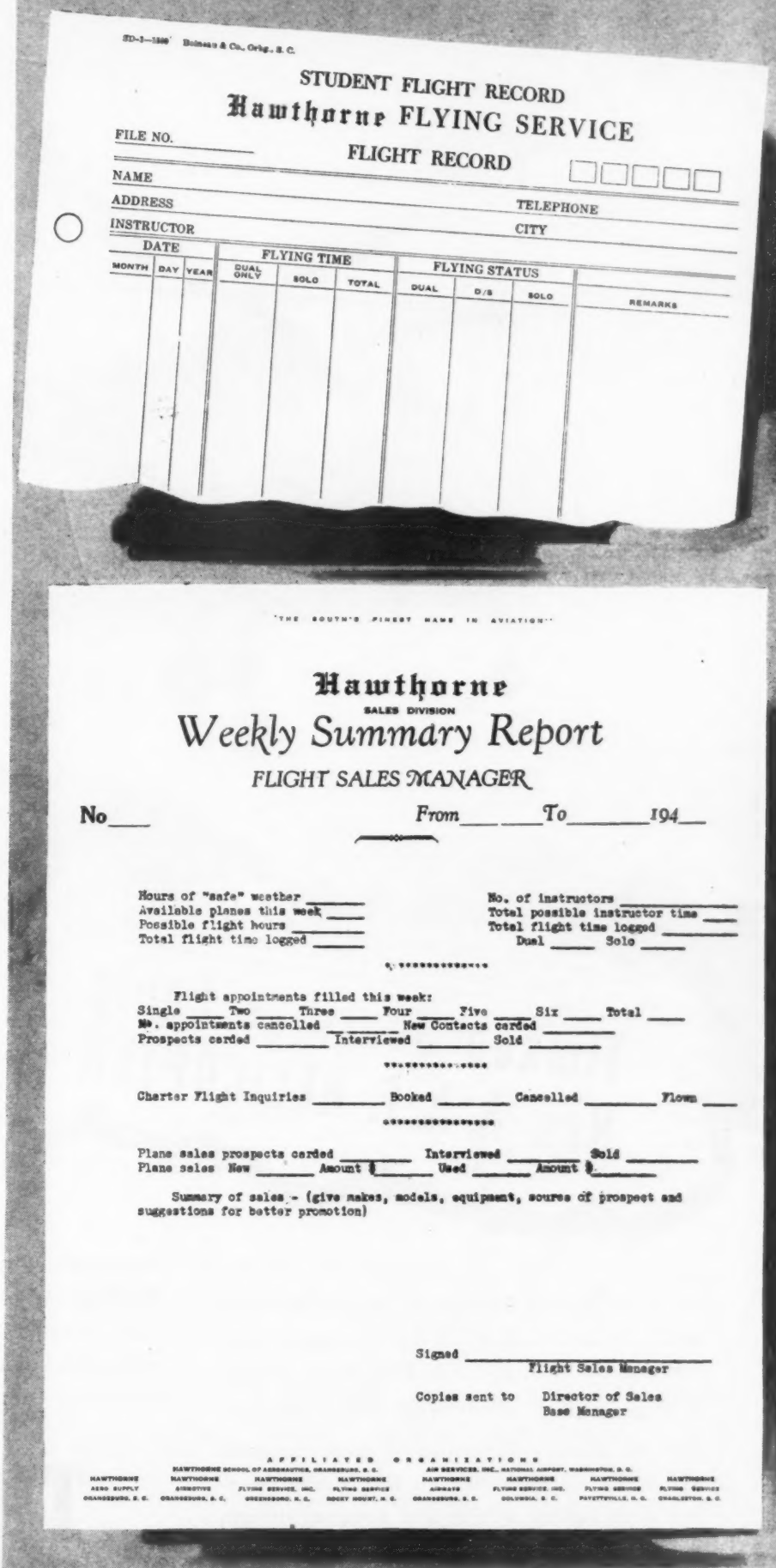
Another phase of Hawthorne's "statistical control" presenting a clear picture of student business is the Weekly Summary Report. It includes space for checks on three different phases of the student business. First is the percentage of revenue time logged in relation to "possible flight hours," which is determined by multiplying the number of planes available for student work and the number of hours of flyable weather.

The second portion of the form concerns flying time put in by instructors in relation to total possible instruction time. A survey of several years of operating experience at Hawthorne indicates that an instructor should spend 35% or more of the available instruction time in the air. A trainer-plane should log a minimum of 40 hr. of revenue time per month to justify its existence.

The third appraisal on the weekly report is the number of flight appointments (lessons) given during the week, broken down into the number of students flying only one time, the number flying two times, etc. It also lists the number of prospects interviewed and the number who actually took a lesson.

This report is made by the Flight Sales Manager and turned over to the base manager. It has proven invaluable in giving a reasonably up-to-date report on the base's student business.

Besides expediting a definite procedure for following-up the no-return students, this over-all system has had an added advantage (1) of showing Hawthorne where promotion emphasis should be placed, (2) of indicating the type of prospect most likely to buy flying time, and (3) of keeping personnel and equipment operating at an efficient level. Above all, it has shown that current students will fly a lot more if basic principles of salesmanship are applied.



STUDENT FLIGHT RECORD

Hawthorne FLYING SERVICE

FILE NO. _____ FLIGHT RECORD

NAME _____

ADDRESS _____ TELEPHONE

INSTRUCTOR _____ CITY

DATE			FLYING TIME			FLYING STATUS			
MONTH	DAY	YEAR	DUAL ONLY	SOLO	TOTAL	DUAL	D/S	SOLO	REMARKS

"THE SOUTH'S FINEST NAME IN AVIATION"

Hawthorne

SALES DIVISION

Weekly Summary Report

FLIGHT SALES MANAGER

No___ From___ To_____ 194__

Hours of "safe" weather _____
Available planes this week ____
Possible flight hours _____
Total flight time logged _____

No. of instructors _____
Total possible instructor time ____
Total flight time logged _____
Dual _____ Solo _____

Flight appointments filled this week:
Single ____ Two ____ Three ____ Four ____ Five ____ Six ____ Total ____
No. appointments cancelled _____ New Contacts carded _____
Prospects carded _____ Interviewed _____ Sold _____

Charter Flight Inquiries _____ Booked _____ Cancelled _____ Flown ____

Plane sales prospects carded _____ Interviewed _____ Sold _____
Plane sales New _____ Amount $_____ Used _____ Amount $_____

Summary of sales - (give makes, models, equipment, source of prospect and suggestions for better promotion)

Signed _____
Flight Sales Manager

Copies sent to Director of Sales
Base Manager

AFFILIATED ORGANIZATIONS

HAWTHORNE AERO SUPPLY Orangeburg, S. C. — HAWTHORNE SCHOOL OF AERONAUTICS, Orangeburg, S. C. — HAWTHORNE AIRDRIVE Orangeburg, S. C. — HAWTHORNE FLYING SERVICE, INC. Greensboro, N. C. — HAWTHORNE FLYING SERVICE Rocky Mount, N. C. — AIR SERVICES, INC., National Airport, Washington, D. C. — HAWTHORNE AIRMATE Orangeburg, S. C. — HAWTHORNE FLYING SERVICE, INC. Columbia, S. C. — HAWTHORNE FLYING SERVICE Fayetteville, N. C. — HAWTHORNE FLYING SERVICE Charleston, S. C.

Here are two easily-maintained records that Hawthorne Flying Service has used to tremendously increase student repeat business. At top is Student Flight Record which gives both sales manager and instructors all pertinent data on each student, greatly simplifying follow-up work. Seen above is Sales Manager's Weekly Summary Report, enabling quick and accurate check on amount of business done.

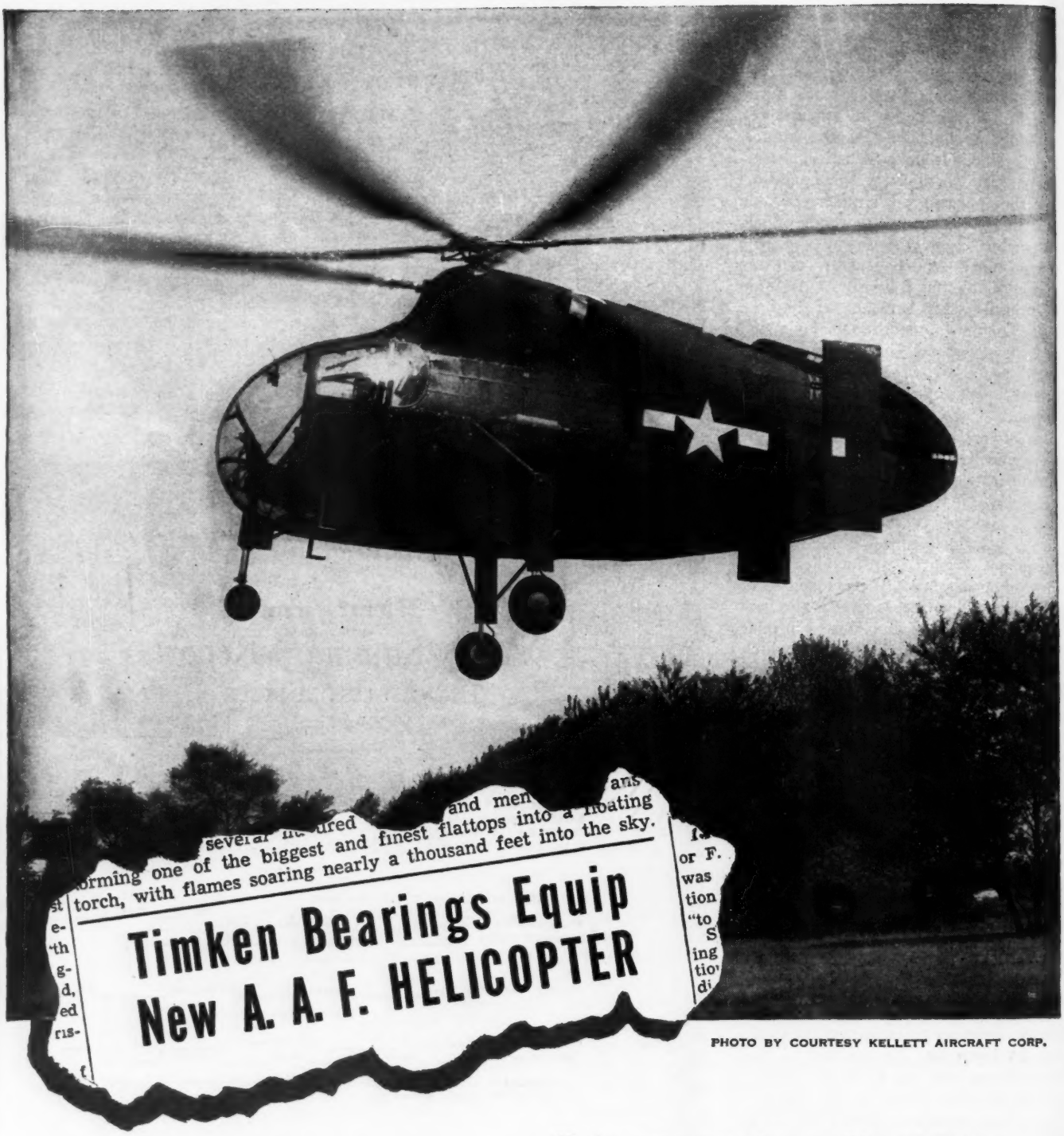


PHOTO BY COURTESY KELLETT AIRCRAFT CORP.

Twenty Timken "Aircraft" Bearings equip the new Kellett XR-8 Helicopter—made for the U. S. Army Air Forces—at twenty vital points of its main drive and wheels.

Part of a series developed to meet the need of aircraft engineers for an anti-friction bearing with lighter weight and compact design, Timken "Aircraft" Bearings also assure maximum radial and thrust load-carrying capacity . . . smoothness of operation . . . economical maintenance . . . and ease of operation . . . as well as power conservation and endurance.

If the many matchless qualities of Timken Bearing design for aircraft applications can help, consult us. We'll be glad to make recommendations. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN
TAPERED ROLLER BEARINGS

The "TIMKEN" Trade-mark is a good thing to look for . . . a protection to find.

DESIGN ANALYSIS OF

Messerschmitt Me-262 Jet Fighter

PART I—THE AIRFRAME

By **JOHN FOSTER, JR.,** *Managing Editor, "Aviation"*

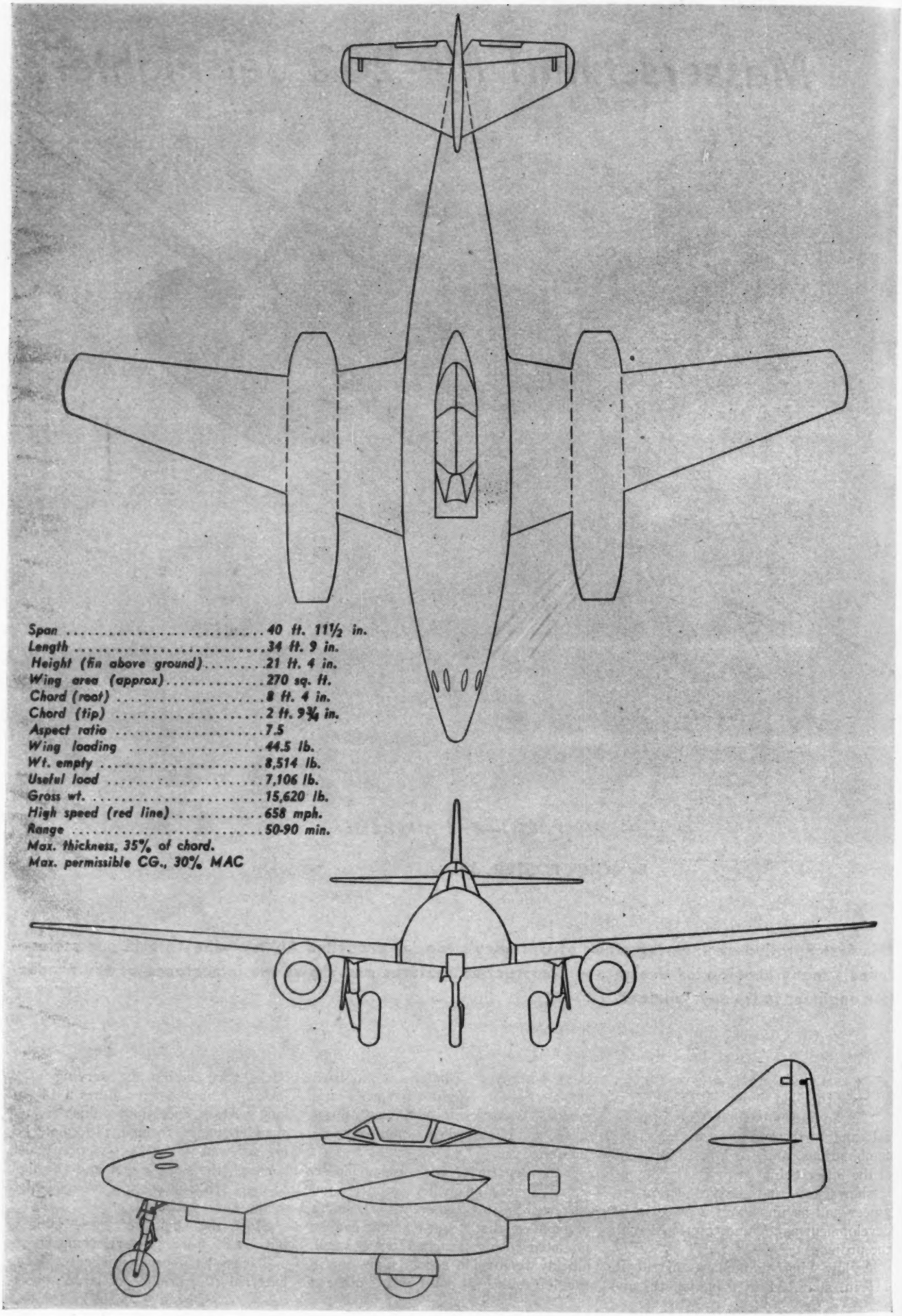
This first detailed engineering study of Germany's top jet propelled fighter—the 15th in our series—reveals many unorthodox design and construction features and shows the importance of the production engineer in its development.

GERMANY'S MOST SUCCESSFUL jet propelled plane, the Me-262, is an unusual combination of radical and orthodox design, materials combinations, and workmanship, some of the latter being surprisingly sloppy. It shows, too, that the production engineer had as important a place in its development as anyone connected with the project.

A low-wing monoplane of 40 ft. 11½ in. span, 34 ft. 9-in. length, and 11 ft. 4-in. over-all height, it was used as a fighter, fighter-bomber, and ground attack craft, and was apparently also designed for photo reconnaissance use.

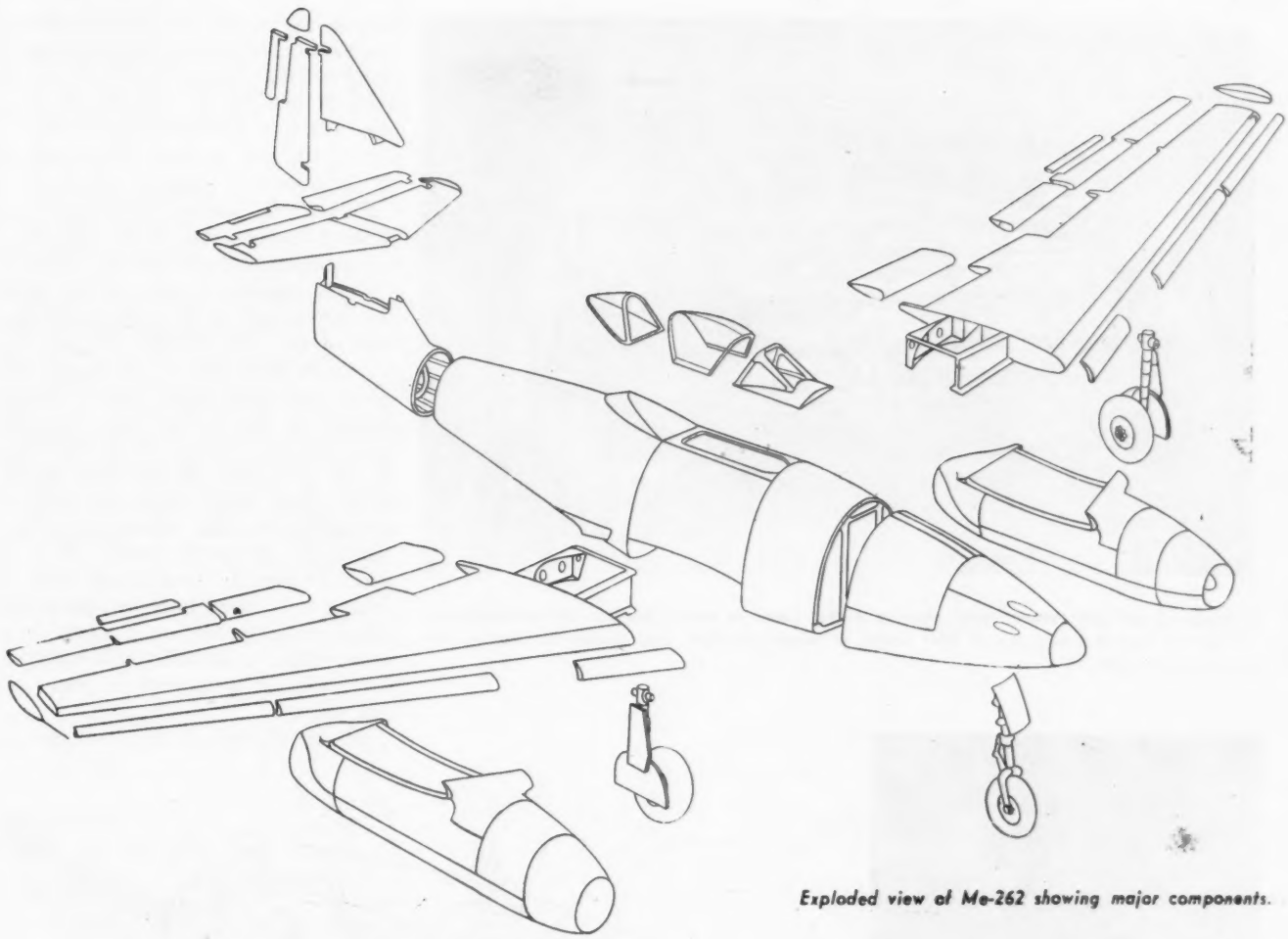
The very tip of the fuselage looks exactly like a propeller spinner—and may well be just that—with a hole cut in front so that a gun camera can be mounted inside, reached by a small, quickly removable access plate set in the left side. A solid web bulkhead backs this section up, serving as a jacking point. Then follows a 14½-in. long section enclosing a flush-riveted channel-shaped former, the whole being screwed to the next section which contains the nose wheel and the four 30-mm. MK-108 cannon grouped high in the nose section.

Since the length of these guns is but 3 ft. 6-in., a very compact installation has been achieved with no external projections. A large spheri-



Span	40 ft. 11½ in.
Length	34 ft. 9 in.
Height (fin above ground)	21 ft. 4 in.
Wing area (approx)	270 sq. ft.
Chord (root)	8 ft. 4 in.
Chord (tip)	2 ft. 9¾ in.
Aspect ratio	7.5
Wing loading	44.5 lb.
Wt. empty	8,514 lb.
Useful load	7,106 lb.
Gross wt.	15,620 lb.
High speed (red line)	658 mph.
Range	50-90 min.

Max. thickness, 35% of chord.
Max. permissible CG., 30% MAC



Exploded view of Me-262 showing major components.

cal support around the barrel near the aft end facilitates adjustments during sighting in operations.

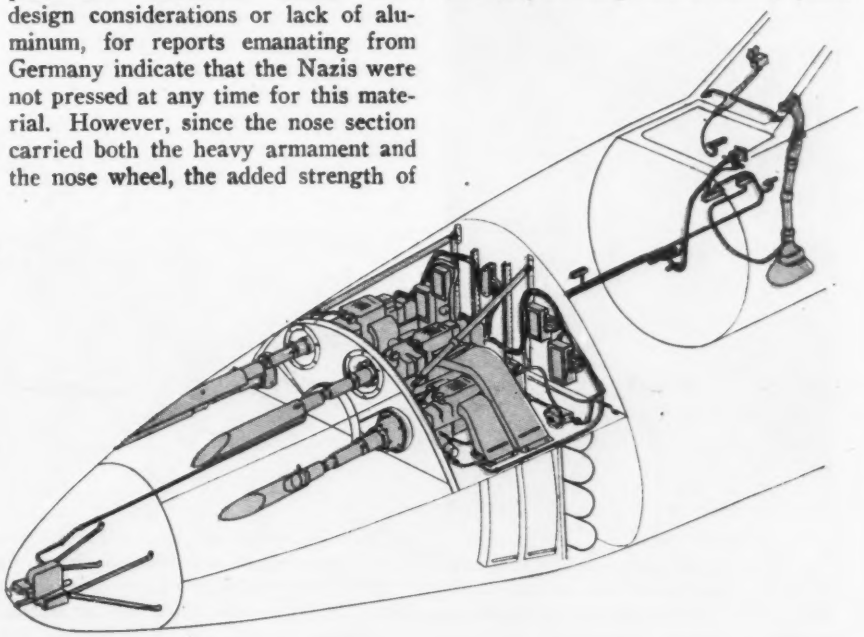
The guns are usually set to converge at 450 meters. The MK-108 fires 575-600 rounds per min. with a muzzle velocity of 1,570 fps., and weighs but 134 lb. Compressed air for charging is carried in eight bottles set inside the fuselage on the left ahead of the cockpit.

The two top guns carry 100 rounds each, the bottom pair 80 each, and all are fired simultaneously by a switch on the contact stick.

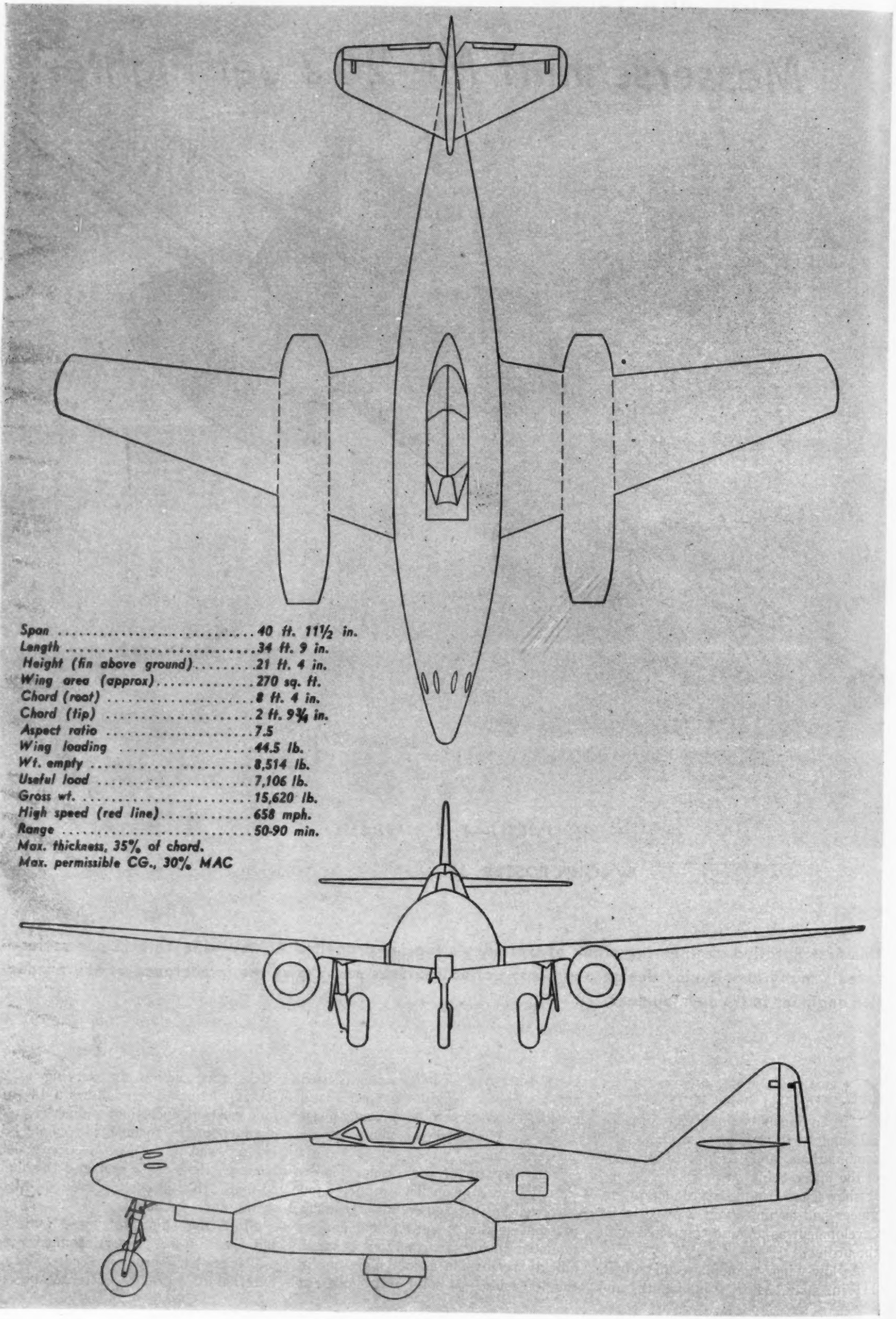
Although the 262 was designed as an interceptor, Hitler ordered it made into a bomber. The result was installation of two jettisonable bomb racks, each carrying one 550-lb. bomb. Additional armament on later models consisted of 24 R4M 5-cm. rockets, 12 under each wing, and it is reported that the Germans planned to install up to 48 under each wing.

Skin of the 6 ft. 5½-in. long section aft of the spinner is of .080 sheet steel. Since the cannon are mounted high, the use of steel in that section is understandable because of the blast effect, but even the belly skin is of the same material. It is possible the employment of steel was dictated by transportation difficulties rather than design considerations or lack of aluminum, for reports emanating from Germany indicate that the Nazis were not pressed at any time for this material. However, since the nose section carried both the heavy armament and the nose wheel, the added strength of the steel may have been a deciding factor.

The cannon are most accessible, for two 35¼-in. long access doors, piano

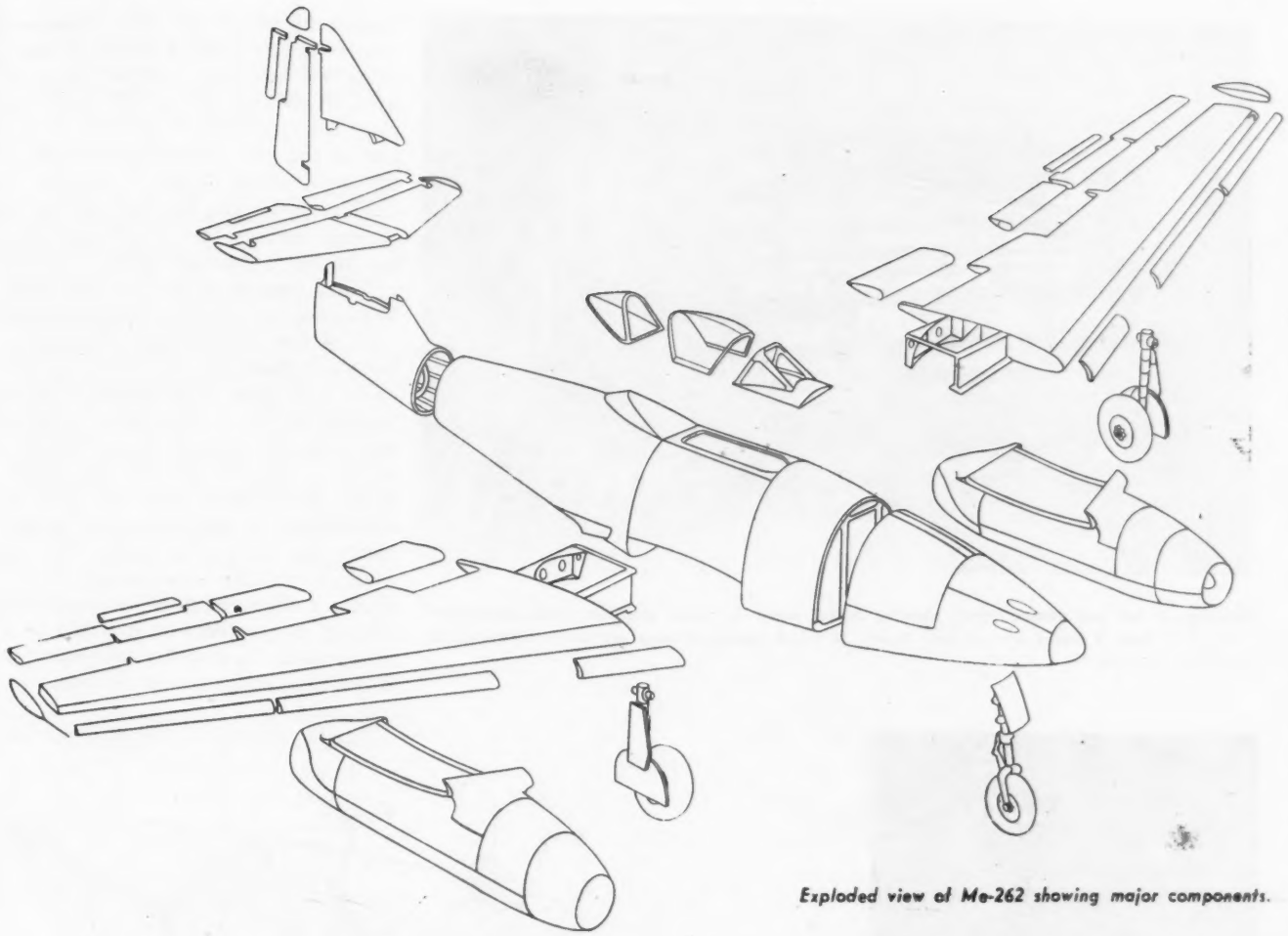


Phantom view showing installation of gun camera in nose, four 30-mm. MK-108 cannon, with ejector chutes below, and electrical connections for firing.



Span	40 ft. 11½ in.
Length	34 ft. 9 in.
Height (fin above ground)	21 ft. 4 in.
Wing area (approx)	270 sq. ft.
Chord (root)	8 ft. 4 in.
Chord (tip)	2 ft. 9¾ in.
Aspect ratio	7.5
Wing loading	44.5 lb.
Wt. empty	8,514 lb.
Useful load	7,106 lb.
Gross wt.	15,620 lb.
High speed (red line)	658 mph.
Range	50-90 min.

Max. thickness, 35% of chord.
Max. permissible CG., 30% MAC



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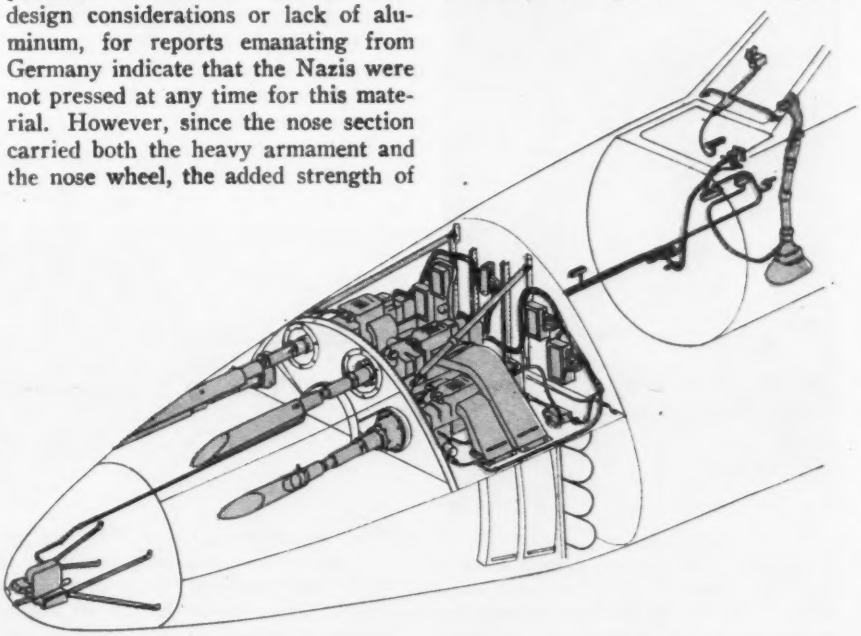

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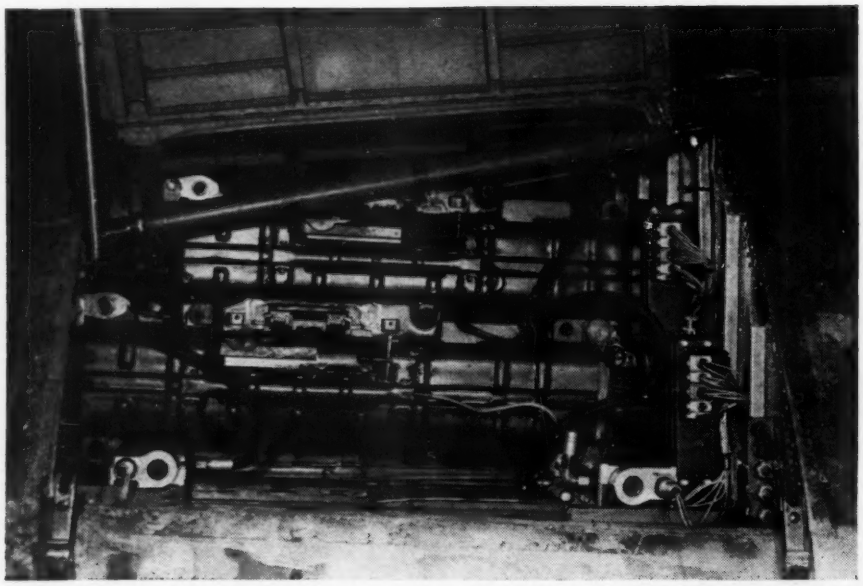


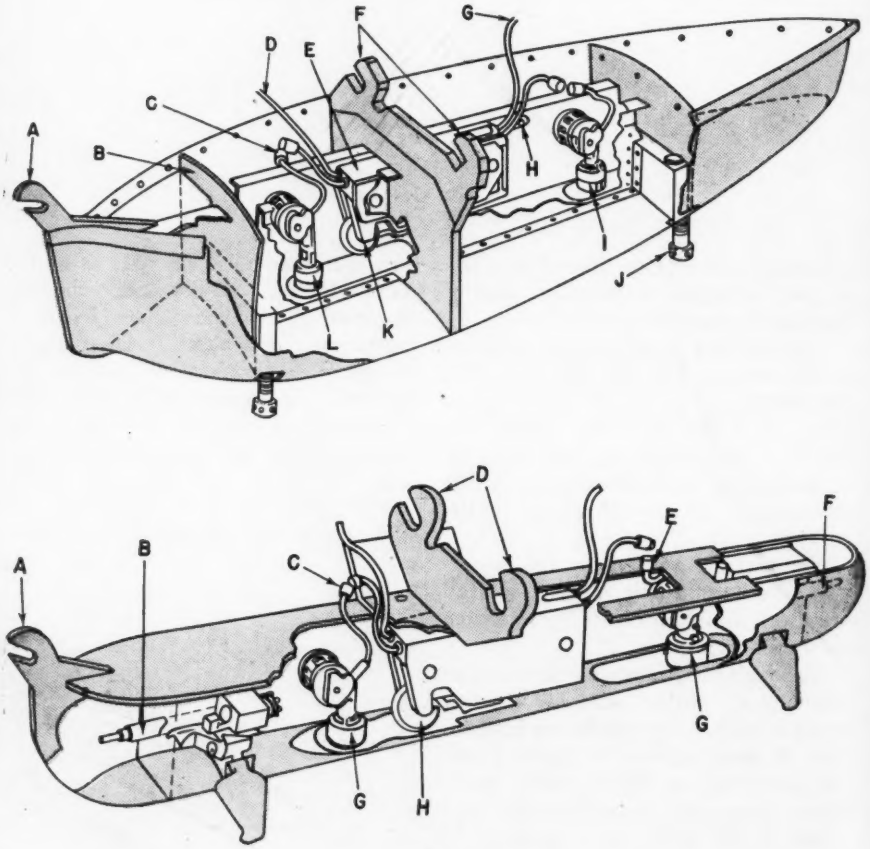
Closeup up left gun compartment, showing access panel in raised position. Note turnbuckle tie rod at top; it makes one of four points at which complete nose section is attached to bulkhead at right.

hinged 1½ in. off the top centerline, can be quickly opened simply by loosening two flush toggle latches like those used on cowling of the FW-190 (see page 131 Oct. 1944 AVIATION) exposing all the gun mechanism as well as the ammunition drums.

This whole nose section attaches to the mid-fuselage in a simple but effective manner. At each lower corner is a 1-in. (approx.) high-tension steel bolt fastening it to the solid web bulkhead of the mid-section. At the top, some 6 in. from the centerline, are two 1½-in. steel tubes, also bolted to forged fittings on the mid-section bulkhead and extending forward to the bulkhead at the front end of the gun access doors. Both these tubes are built as turnbuckles so that alignment adjustments can be easily made. Thus it would be possible for a trained crew to change a damaged nose section in the field in short order, or it would be a simple matter to install a nose equipped with different armament or photo recon units.

At the aft end of the nose section,

View from below fuselage connection, showing how through bolt—one on each side—joins nose to mid-fuselage section. After connection is complete, access holes are covered with doped fabric. At top is one of quick fasteners by which cowling over gun compartment is held in place.



Hitler ordered Me-262 used as bomber, even though it had been designed as interceptor, so two types of bomb racks were developed. Type A is at top, showing: Forward suspension point (A); forward bulkhead (B); three-point connection to fuzing arm (C); power lead to fuzing arm (D); bomb release slip (E); aft suspension points (F); power lead to release circuit (G); mechanical jettison rod (H); charging head (I); adjustable crutch (J); suspension hook (K); and charging head (L). Type B (bottom) shows forward suspension point (A); crutch ratchet (B); power lead to fuzing arm (C); aft suspension points (D); lead to fuzing arm (E); crutch ratchet (F); charging heads (G); and suspension hook (H).

Phantom view showing cylindrical-section cockpit in fuselage. This "liner" section is designed for pressurization, but craft and reports studied reveal Nazis did not actually pressurize Me-262 in operation.

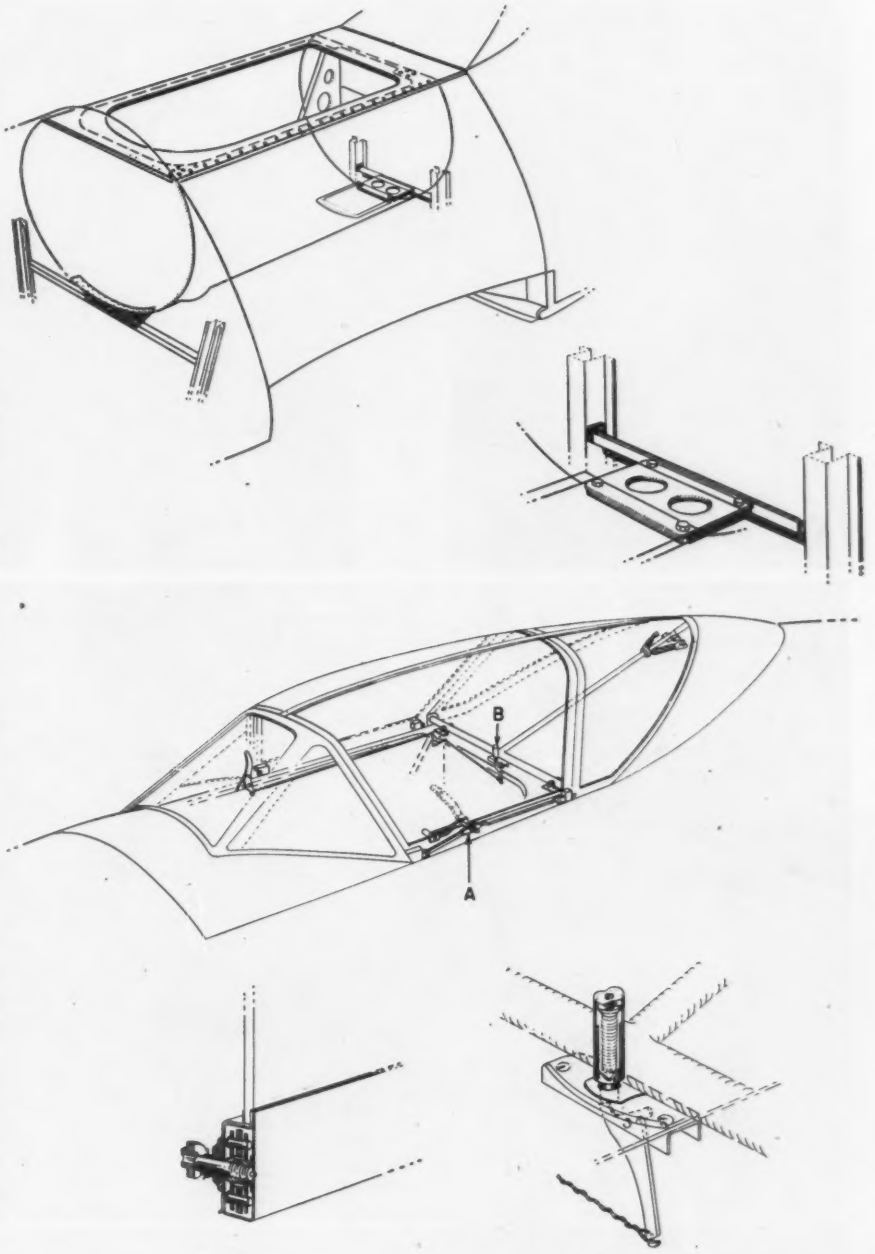
the Me-262's fuselage cross section is practically an equilateral triangle, only slightly rounded out.

First bulkhead in the mid-fuselage section is solid web aluminum alloy with six vertical and two horizontal hat shaped stiffeners.

At a point 16¾ in. back is a channel shaped former, flush riveted to the skin, and 16 in. farther aft is another solid web bulkhead, with vertical and horizontal hat shaped stiffeners. Practically all the space between the two solid bulkheads is taken up by the fore fuel cell (which will be discussed in detail in the section devoted to the fuel system). The bottom panel of this section consists of a waffle grid, double stressed skin, 34¾ in. long and 55 in. wide. The panel is attached to the fuselage by flush screws and captured nuts, the same system employed on the FW-190 panel beneath the fuel cells. Interchangeability of these panels evidently was not much of consideration in Me-262 production, for the screws were set approximately 1¾ in. apart but with variations of as much as ¼ in. and considerable misalignment.

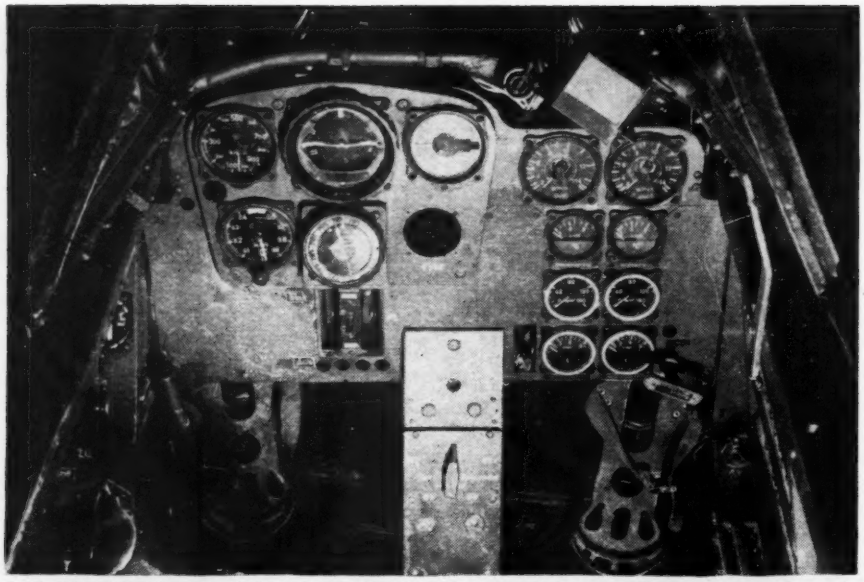
Every Nazi pilot apparently was his own Führer, for the Germans call the next section the *Führerraum*, or pilot space. And they must have been little Führers, for the rudder pedals are quite close to the seat and there is no fore-and-aft adjustment either on the pedals or seat. An average sized American sitting in the cockpit finds his knees sticking well up in the air right in front of some of the instruments.

Only one channel-shaped former extends from the cockpit rail to the bottom of the fuselage at the cockpit which is, in effect, a horizontally-disposed cylindrical section with part of the wall sliced off. This "cockpit liner" section was designed for pressurization, but the craft examined had no means of developing pressure and there are no reports of any of the 262's actually operating in combat with pressurization.



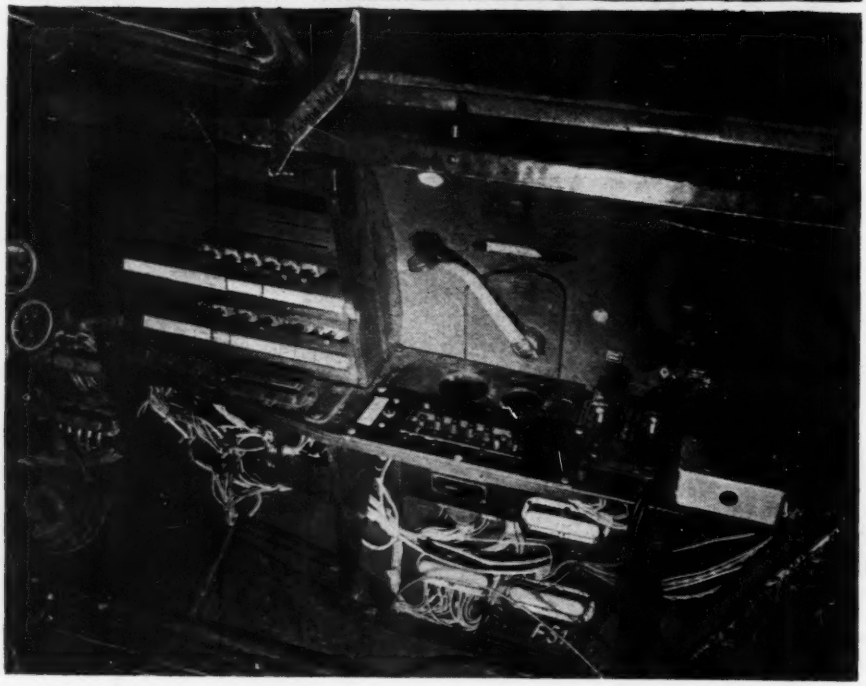
Detail sketch of cockpit canopy, showing jettison lever on pilot's right and locking lever at his left. Front windshield panel is 3½-in. thick bullet-proof glass. No side or bottom armor protection is provided.

Me-262 canopy open, showing jettison lever and cable at pilot's right. Note curved silhouette armor plate which fits over pilot's head. Evidently this was modification of original design, for basic plans shows no such installation. At windshield base at left can be seen cockpit ventilating scoop. Apparently this was also a last-minute modification, one which showed workmanship far below normal German standards.

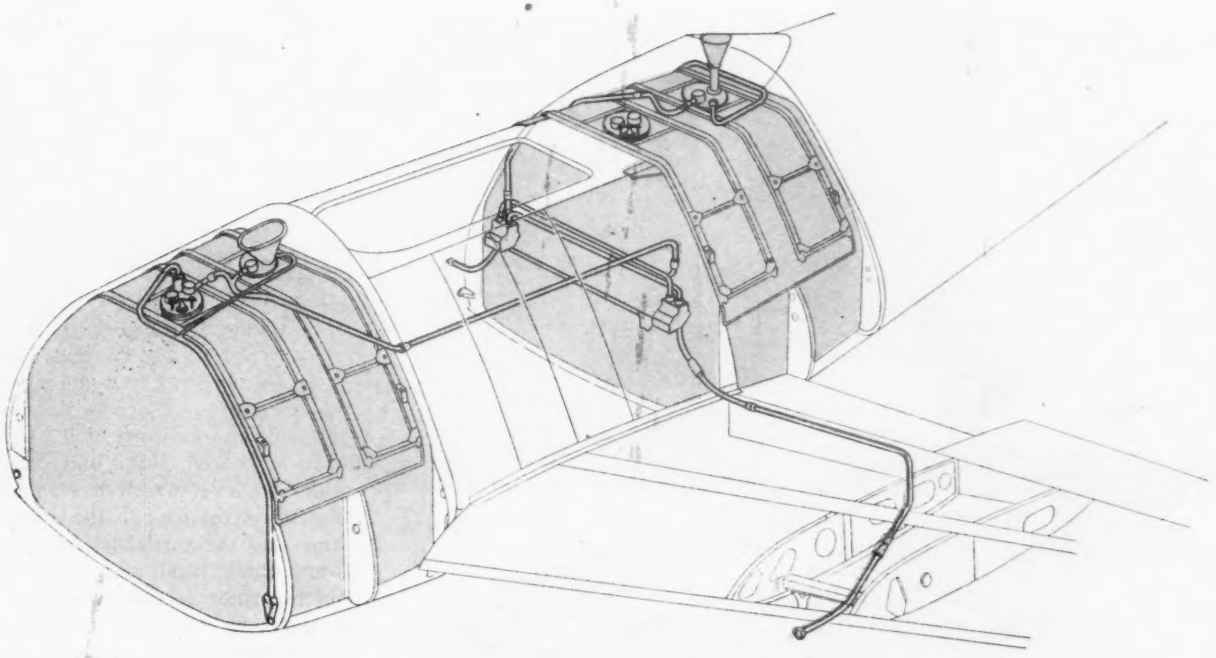


Main instrument panel, with flight instruments at left, engine instruments at right, and bomb switches on panel at lower center. Note how gunsight at top has been swung to right out of way for landing and takeoff. Engine instruments, from top to bottom are: Tachometers, gas temperature gages, lube oil pressure gages, and fuel supply indicator. Original design called for installation of gas pressure indicators alongside temperature gages, also fuel injection pressure gages alongside oil pressure gages.

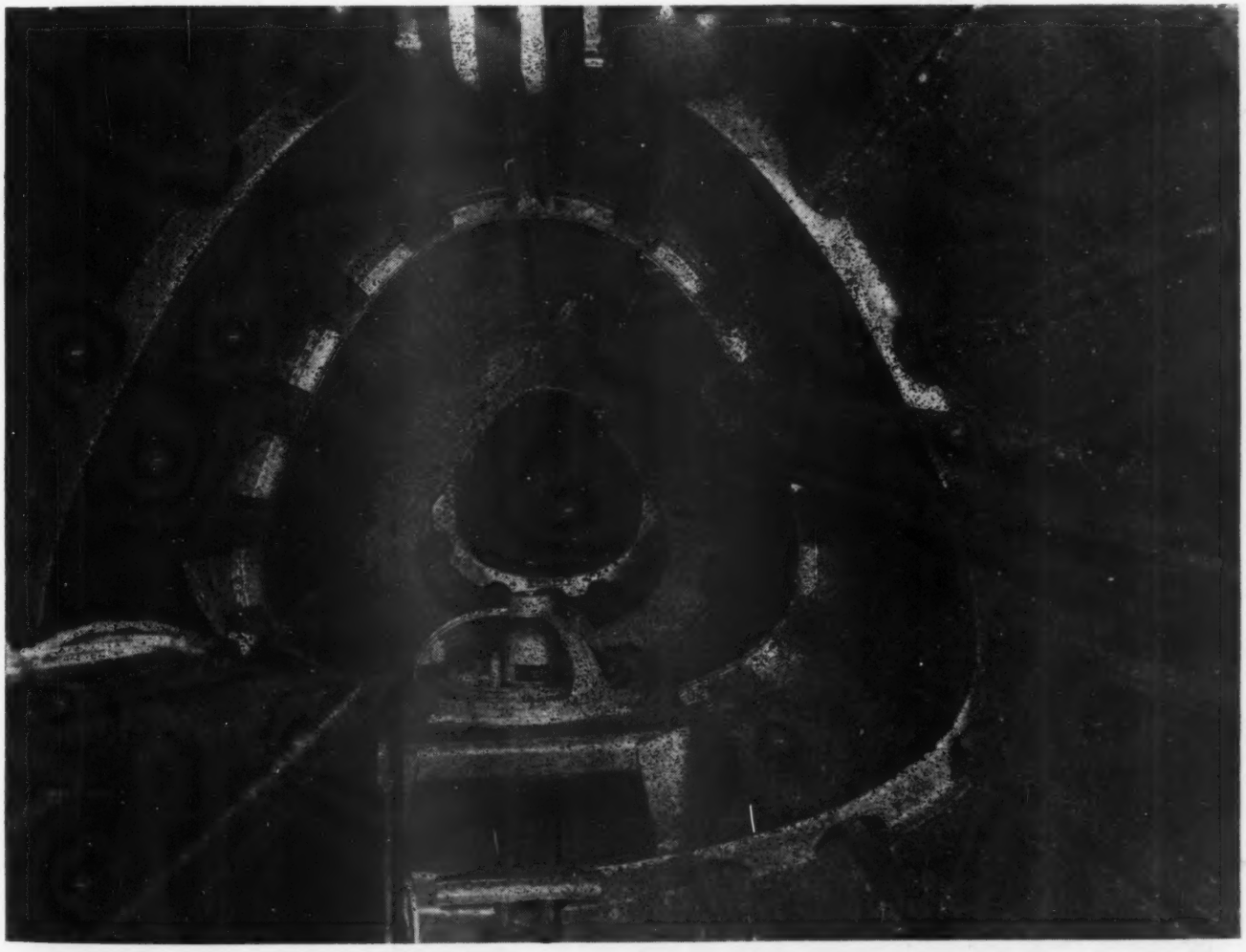
Left side of cockpit showing, on diagonal panel: Oxygen flow indicator, emergency landing gear and flap operating switches, and oxygen valve. On horizontal panel, from front to rear, are: Landing gear and flap position indicators, landing gear and flap operating buttons, stabilizer pitch indicator and operating switch, emergency master cut-off switch, throttle quadrant, and (not in photo) fuel selector valves, rudder trim tab crank, and jet assisted takeoff unit jettison release. At base of front panel can be seen pull handle for nose wheel brake, and at right, beneath left windshield panel, is lever to open or close cockpit ventilating scoop.



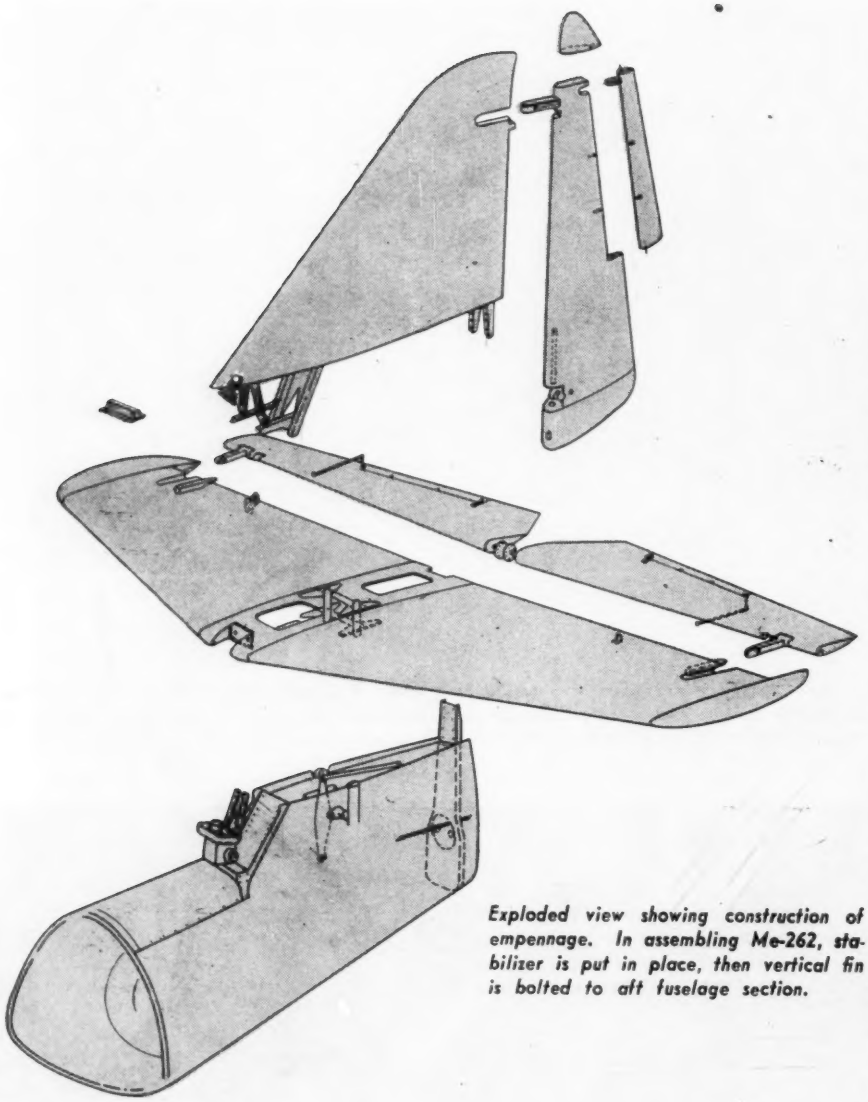
Right side of cockpit showing, at windshield base, canopy jettison lever below which are, from left to right: Pitot heater, Very signal, radio frequency selector and on/off switches, and tachometer low-speed selector switches. Curved handle in fuselage side is bomb release. Pulling it clear back beyond bomb release stop jettisons bomb racks.



Phantom view showing two main 238-gal. fuel tanks just fore and aft of cockpit. Each tank is fitted with two booster pumps, and selector valves permit pumping from either tank to either engine, or from aft to fore tank. A 53-gal. reserve tank can be installed below cockpit, and Nazis had plans for an additional tank to go behind aft unit, with approximately half its capacity.



Inside aft fuselage, with radio in left foreground, are seen master compass in center, oxygen bottles at top, and elevator, rudder, and rudder trim tab torque tubes at right. Shown are typical stringers which completely replace longerons. Formers in this section are integral part of skin sheets, which are joggled to thickness of metal for lap joint, then bent inward to make "J" or channel section.



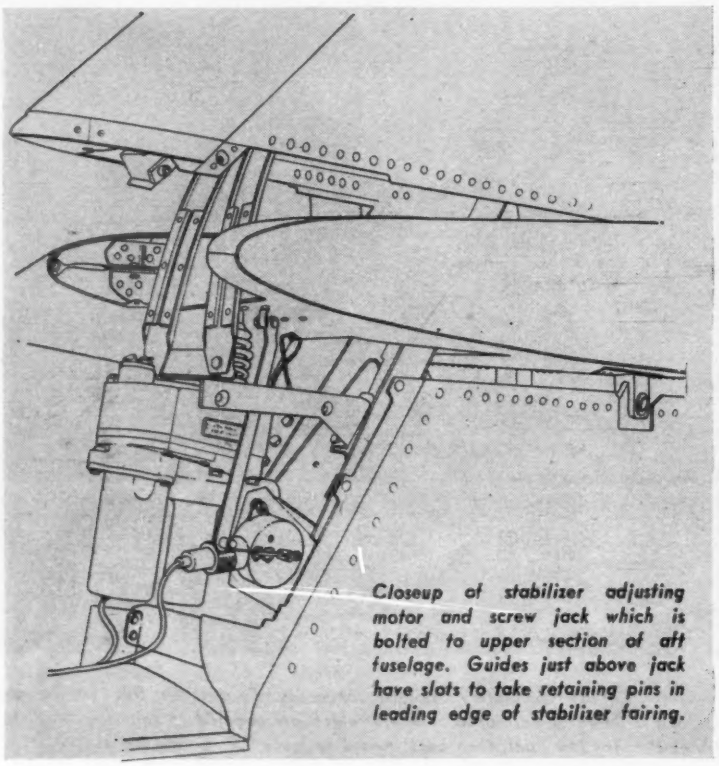
Exploded view showing construction of empennage. In assembling Me-262, stabilizer is put in place, then vertical fin is bolted to aft fuselage section.

Further evidence that cockpit pressure was an unused design feature is found in the windshield, a conventional three-piece flat-plate unit in which the front piece is 3½-in. bullet proof glass, set in a steel frame, but merely screwed in without the usual synthetic rubber mounting found on other German craft. The seal—which certainly does not appear to be designed for pressure—appears to be plastic designed only to prevent normal air leakage.

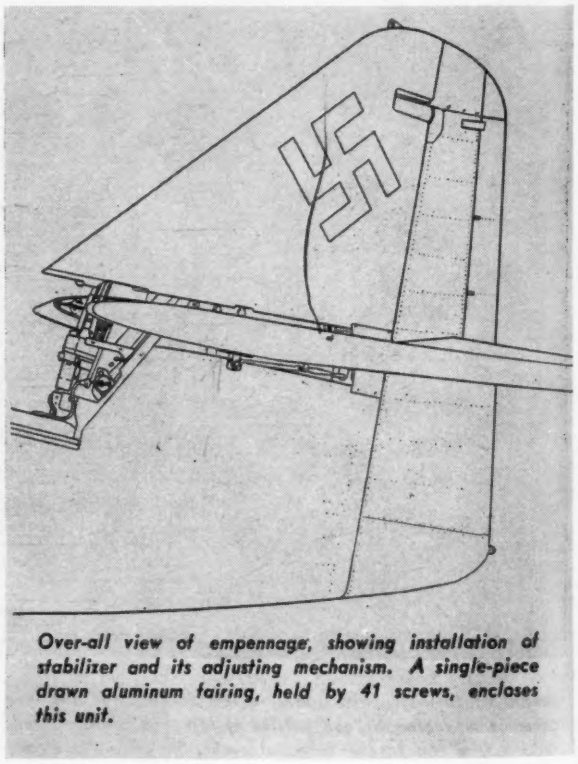
The cockpit canopy consists of two rounded plastic glass sections mounted in a frame with flat fore-and-aft pieces and tubular base. It pivots on the right side for entrance and exit, and it can be locked closed only from the inside by a lever which drives pins into holes set in the base of the windshield frame and the turtleback section. A 16-mm.-thick head and shoulder silhouette armor section, which extends up and over the back of the pilot's head, is bolted to the canopy frame just ahead of the turtleback section.

Either the Germans changed their own minds about instrumentation or had them changed by Allied bombing, because original designs called for more instruments than are actually installed—at least that's the case on some late planes. The main instrument panel is divided in two sections, with flight instruments on the left, engine instruments on the right.

Flight instruments include: Artificial horizon, combined with bank and turn indicator, airspeed indicator (some of which have been red lined at 658 mph.), altimeter, rate of climb



Closeup of stabilizer adjusting motor and screw jack which is bolted to upper section of aft fuselage. Guides just above jack have slots to take retaining pins in leading edge of stabilizer fairing.



Over-all view of empennage, showing installation of stabilizer and its adjusting mechanism. A single-piece drawn aluminum fairing, held by 41 screws, encloses this unit.

Detailed photo of mass-balanced elevator trim tab, evidently originally designed as servo unit but in actual practice riveted in place by gusset plates (shown at either end). Note that trailing edge of tab is neatly flush riveted, but elevator itself has ordinary rivets.

indicator, repeater compass, and blind approach indicator.

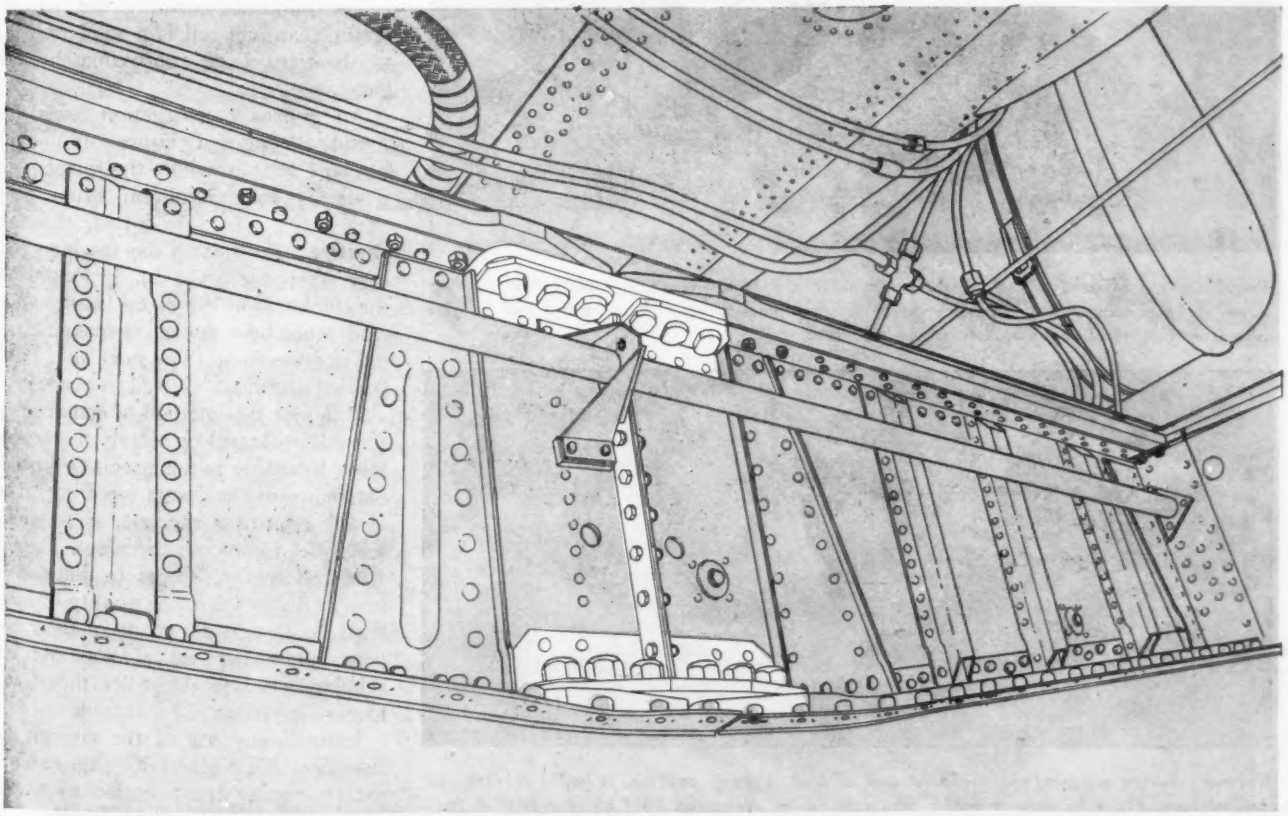
Engine instrumuents include: Two tachometers of two-speed variety to give readings from 0–3,000 rpm. and from 2,000–15,000 rpm. (generally red-lined at 8,900 rpm.); two gas pressure gages indicating up to 1 kg./cm.^{2}; two gas temperature gages indicating up to 1,000 deg. C. (with marks on the gages at 680 deg.); two oil pressure gages; and fuel gages for front and rear tanks. Called for in design plans, but not installed in craft studied, were two fuel injection pump pressure gages, marked at 65 kg./cm.^{2}.

Just below the center of the main panel is the bomb switch panel, marked for dive or level bombing and for instantaneous or delayed action fusing.

Above the main panel is the gunsight, in most cases the old-fashioned REVI 16B relector type, which can be swung to the right out of the way for takeoff and landing.

On a slanting panel just to the left of the main board are valves for emergency operation of flaps and landing gear; oxygen flow indicator; oxygen pressure gages (not on all planes); and oxygen valve.

On a horizontal panel just below this unit are: Position indicators for flaps and landing gear, and buttons, immediately aft for operating both these systems; stabilizer pitch indicator; stabilizer adjusting switch; throttle quadrant; emergency master cutoff switch; fuel selector valves; rudder trim tab crank; and release cable to jettison rocket units for assisted takeoff.



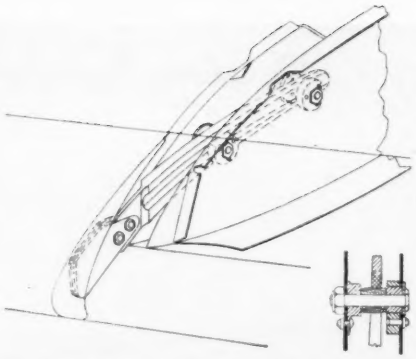
Front face of main spar joint at centerline, showing flanges on aluminum webs bolted together, and steel splice plates on top and bottom of both steel booms. This particular plane had been flown without bolts through splice plates being safety wired. Reserve fuel tank can be installed just in front of spar, being held in position through skin panel screwed to captured nuts (seen on lower boom).

A corresponding panel on the pilot's right contains pitot heater switch; Very signal switches; radio frequency selector and on/off switches; starter switches for starting motors; and switches to select low speed indicator on the tachometers.

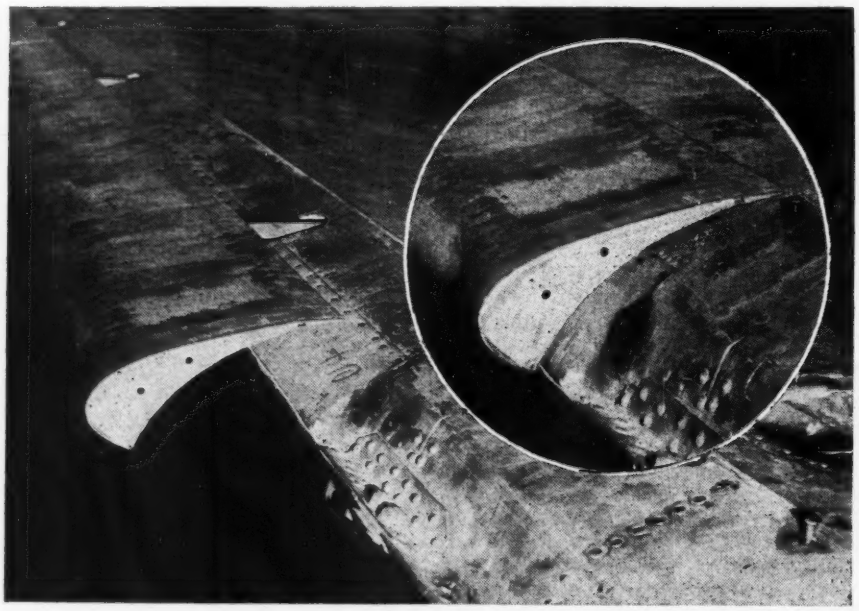
The electric junction box is installed below these panels outside the fuselage cockpit liner, and it is easily accessible from the ground because it is located just above the wheel well.

At the base of the main panel on the left is pull handle for the nose wheel brake, a unit evidently installed to facilitate stopping on the small turfed fields which the Germans were forced to use during the later stages of the war.

Just under the windshield base frame, also on the left, is a pull lever to operate a small square air scoop set in the fuselage side. This apparently was a late factory modification—and the workmanship would certainly never have passed German inspection in the early days.



Phantom sketch showing method of attaching full length slot to guide which travels over ball bearing rollers bolted to nose rib. Slots open automatically at 186 mph. in gliding angle and at 279 mph. in climb.



Detail showing inboard end of steel-skinned outer slot in open position. Note that leading edge of wing is of angular shape, with rolled steel sheet riveted to it behind slot to give proper airfoil. Inset shows slot in closed position.

Closeup showing wingtip and outboard end of slot in open position. Wingtip is attached by bolt, which can be seen in access hole just behind formation light at spar line. A horizontal pin inside leading edge and vertical plate fitting into yoke at auxiliary spar complete three-way tip attachment with use of but one bolt. Note roughness of weld joining upper and lower skin sections of tip.

The pilot's seat is adjustable only up and down on a parallelogram frame, and it is locked in position by a lever under the front of the seat which engages a pin in ratchet teeth. Unlike earlier German craft, the Me-262 has no bungee cord to facilitate moving the seat. The upholstered back of the seat is held in place by two clip springs to facilitate removal for access to the battery, which sits just behind the seat frame.

The seat itself does not incorporate armor plating; this is, instead, attached to channel-shaped vertical and horizontal stiffeners riveted to the solid aluminum alloy bulkhead which begins the aft fuselage section and forms the front panel of the rear fuel cell space. The bottom skin panel for this section measures 35½ x 60 in. and is similar in construction to that under the front cells. In the middle of this fuel cell, some 17¾ in. back, is a former which is built-up double channel section up the sides to the second-from-centerline stringer, from which point it is single channel. This former, like most others, has cutouts for the stringers.

In this connection it is interesting to note that the Me-262 has no longerons, employing only hat-section stringers—one along the top centerline aft of the cockpit; five along the sides (with one ending at former 14); and five along the bottom (the two outermost ending at former 15).

The bulkhead forming the aft end of the rear fuel cell is a solid web but is sheet steel of approximately .080 gage.

An unusual construction feature is found throughout much of the aft fuselage section, where the formers are made of the aluminum skin sheets themselves. In fabrication, the skin sheets are formed to the fuselage contour, then the aft ½ in. is joggled to the thickness of the metal itself—about .050—then bent inward to form a channel or J-section. The next skin is lap jointed and flush riveted in place.

Whether this method of construction should be blamed or merely the type of labor available is not precisely known, but many of the joints were not at all clean, requiring the use of considerable filler to smooth them out. Careful study, however, seems to indicate it was probably more the quality of labor than the design, for many of the rivets were somewhat out of line and had required considerable filler themselves to give anything like a smooth finish.

Immediately aft of the cockpit the fuselage shape starts its change from the triangular cross section to a very narrow elliptical section only 2 ft. wide at a point just ahead of the stabilizer.

Construction of the tail cone is, in some respects, quite like that on the FW-190. It bolts to the aft fuselage section with the joint larded (at least on some planes) with liberal quantities of filler and covered by a doped fabric strip in a vain attempt to get a smooth finish.

The former aft of the joint is a built-up ring riveted to a steel I-beam section which slants aft 47 deg. from the vertical and extends up some 2 ft. above the fuselage top to form the lower part of the front fin spar.

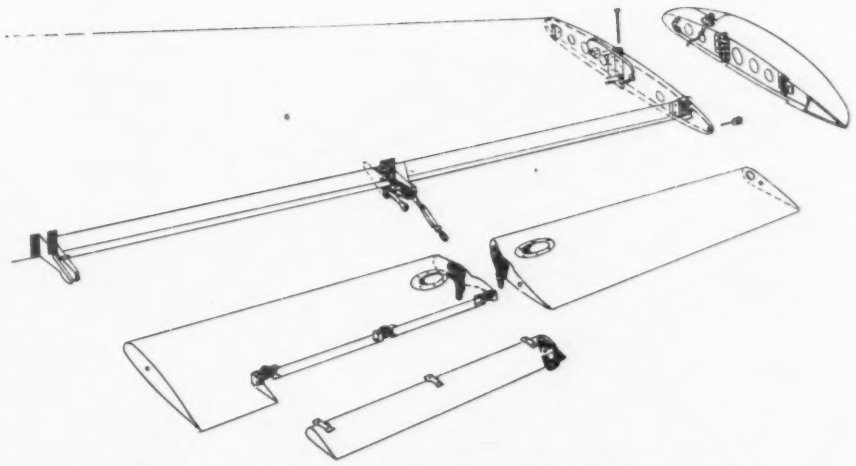
The end of the tail cone, 4 ft. 8¼ in. aft of the former just mentioned, is a stamped flanged aluminum channel section member which also serves as the bottom of the rear fin spar and rudder post.

Connecting the tops of these two spars is a horizontal stamped flanged channel member upon which the stabilizer is mounted. In production, the stabilizer must be installed before the fin and rudder are put in place.

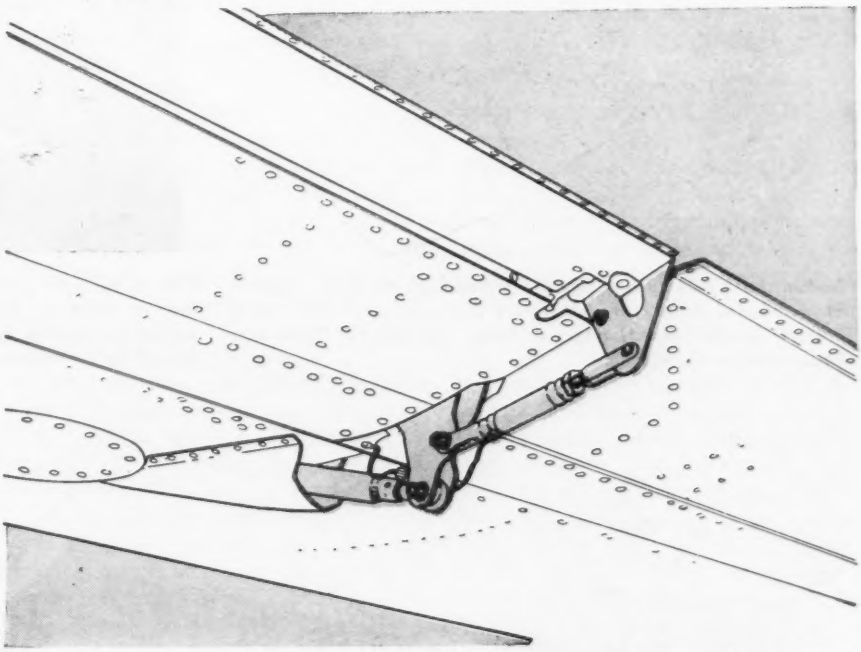
Then the fin, the spars of which have steel plates riveted to their lower ends, is attached to the tail cone by seven bolts along each side of the front spar and four on each side of the rear spar. In construction, the fin is built up in two halves, divided on the vertical plane of the fuselage axis. The halves are then bolted together along the spar line through access holes in the skin. These holes—of approximately 1 in. dia.—are then covered with small doped-fabric patches. The joint along the leading edge is covered by plywood fairing which is screwed on. Rounded tip of the fin is built in two halves, welded together and attached to the main body by flush screws. A single-sheet, deep-drawn aluminum fairing is fastened by 41 flush screws to the base of the fin and top of the fuselage.

Chord of the rudder is narrow, being but 20¼ in. at the widest point, but there is plenty of depth, for the rudder has an over-all height of 6 ft. 11 in., extending from the top of the fin to the bottom of the tail cone. A small tip is screwed to the top just above the large mass balance, and the main section of the unit follows conventional construction practice.

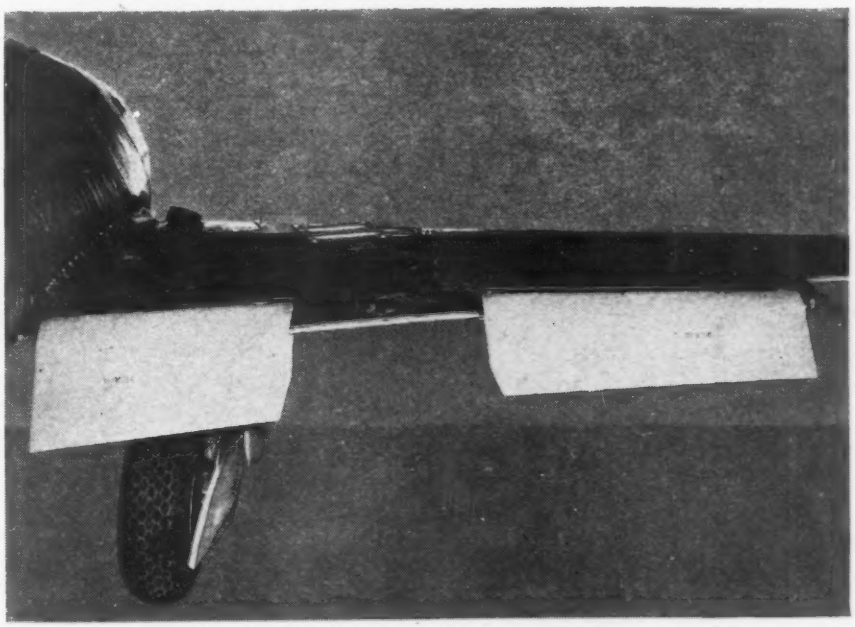
The spar is D-section, with the curved part fitting closely inside the fin trailing edge. Conventional stamped flanged aluminum ribs with lightening holes extend back to the trailing edge, where the skin surfaces are crimped together and riveted with



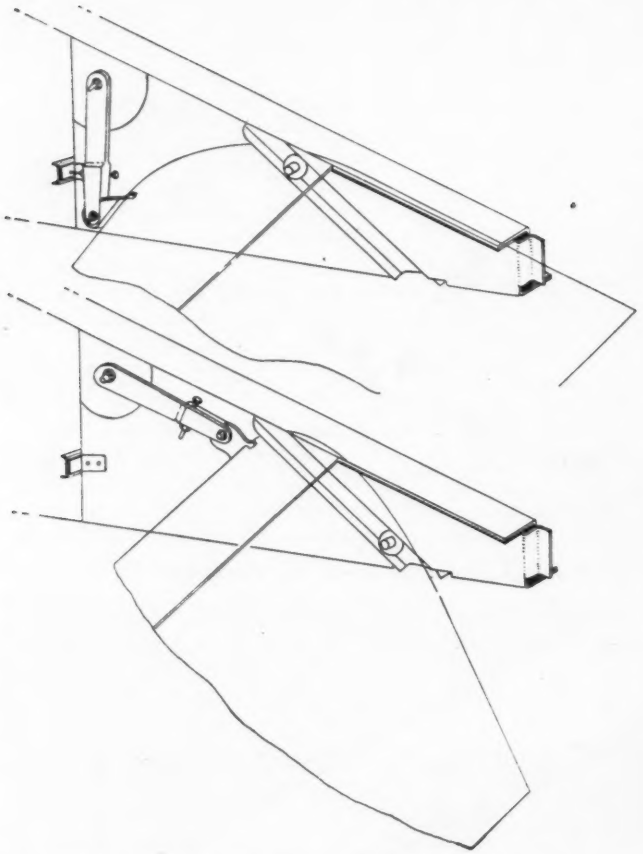
Exploded view of wingtip, two-section aileron, and aileron trim tab.



Aileron trim tab apparently was originally designed as servo unit, but in practice it turned out to be merely ground adjustable through turnbuckle tie rod shown connecting it with aileron control bracket. Note that trailing edge of tab has flush rivets while that of aileron itself uses conventional rivets to hold skin panels to flat strip.

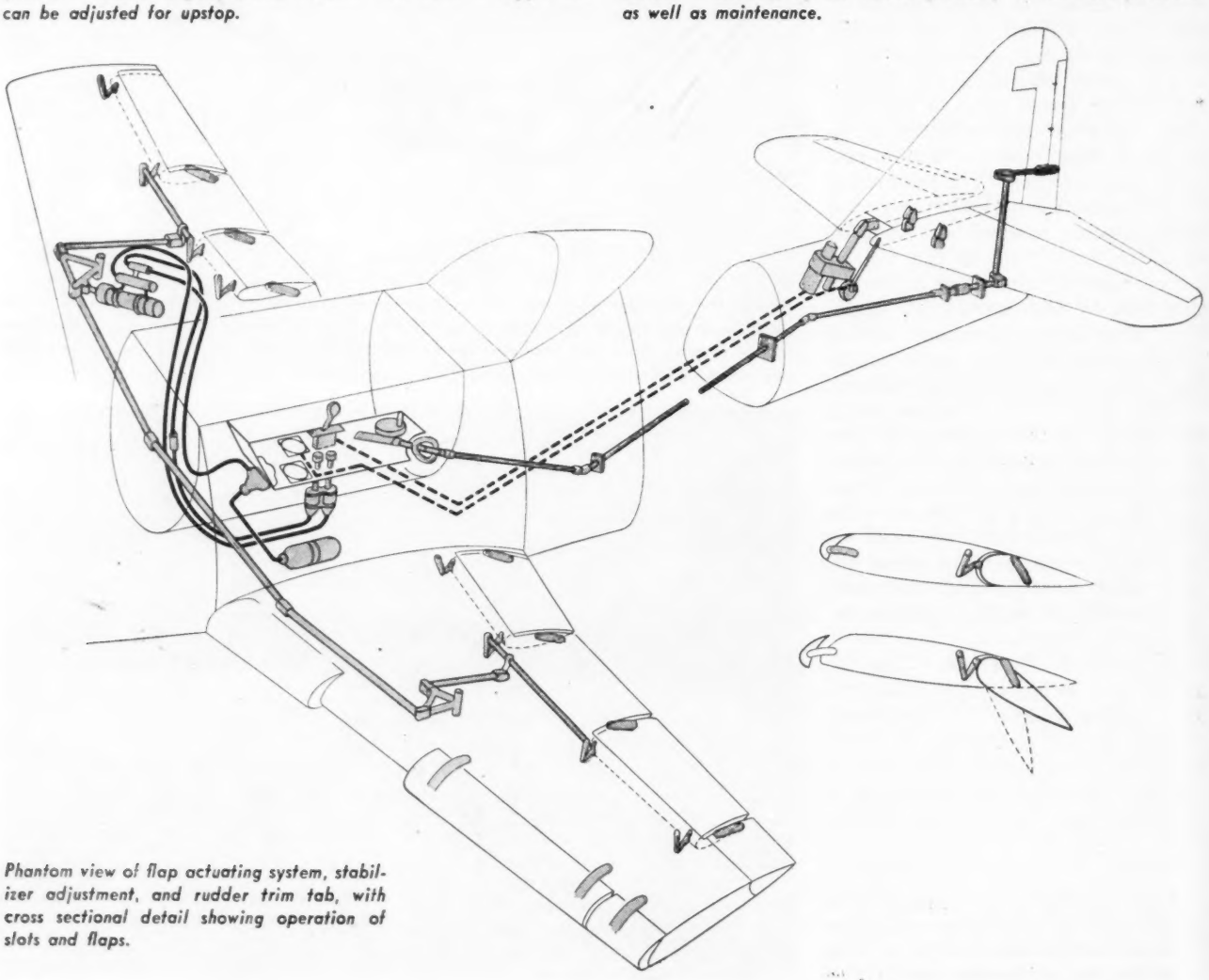


Right hand flaps in fully extended position—down 50 deg. Upper wing surface extends back over slots so that in extended position they are shrouded about 1½ in.



Phantom sketch showing how flaps are moved back and down. Hydraulically-operated toggle at left forces flap back, but 7-in. track (which is channel shaped) moves it down. Set screw in toggle arm can be adjusted for upstop.

Closeup of right inboard flap in extended position showing toggle with its adjusting set screw. Note how one adjacent lower wing surface is attached by flat screws, probably to facilitate production as well as maintenance.



Phantom view of flap actuating system, stabilizer adjustment, and rudder trim tab, with cross sectional detail showing operation of slots and flaps.

⅜-in. ordinary-type round-head rivets.

Fore part of the bottom portion of the rudder, beneath the lower hinge, is comprised of two formed sheets flush riveted to the spar and lowest rib. The aft portion containing the formation light is made up of two small formed sheets attached by flat screws.

Although the rudder is quite deep, it has but two hinges, both typical self-aligning ball bearing units. The top bearing is set just beneath the mass balance, the lower at the bottom rib, where the push-pull controls also attach.

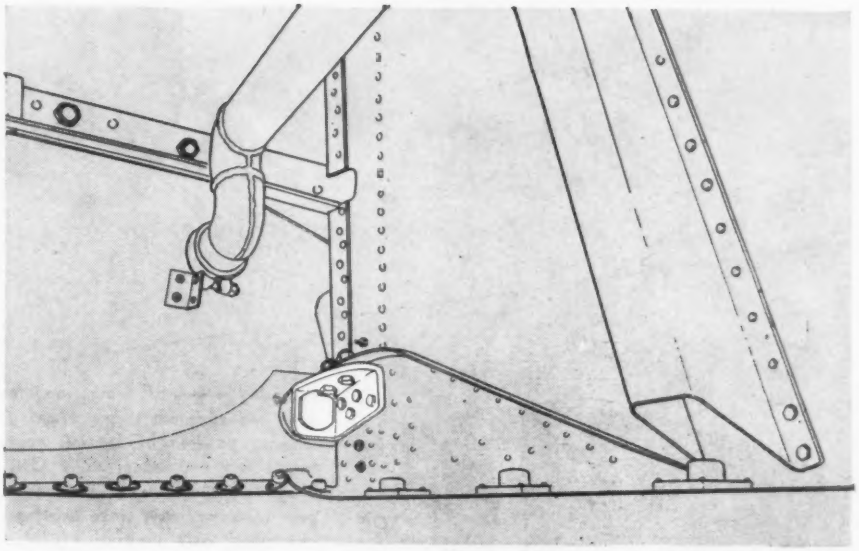
Oddly enough, the combination servo and trim tab has four hinges and, comparing its construction with other parts of the plane, it showed every evidence of having come from a different shop. It too, has a mass balance, set right under the top self-aligning ball bearing hinge. The two middle hinges are small metal blocks with vertical pins holding them to the tab and yokes attaching to the rudder false spar, giving a universal joint effect. The lower hinge is a vertical pin extending up from a rudder rib. Trailing edge of the tab is formed by crimping together the skins, around which a strip is folded and flush riveted. It is 36¾ in. deep, with 4⅞ in. chord at the top and 6 in. at the bottom.

As is the case with several other German planes, the 262's all metal stabilizer is adjustable, the incidence being changed by a small electric motor operating a screw jack mounted inside the fin fairing on the front face of the frame to which the vertical fin is bolted. This unit is very similar to that on the FW-190.

With a span of 12 ft. 4 in., the stabilizer is built in top and bottom halves, which are bolted together through access holes that are later fabric covered. On the craft studied, no attempt has been made to mask the joint along the leading edge, and reports on other planes indicate this was general practice. In view of the workmanship, which left some rather ragged gaps in the skin joint along that edge, it is strange that the manufacturer had not at least applied some filler and fabric.

The stabilizer has a built-up I-beam spar located 24 in. from the leading edge and 18¾ in. ahead of the trailing edge. It is attached to the fuselage by through bolts to two forged fittings set in ball bearings at the axis of the angle adjustment. The leading edge has a 25-deg. sweepback.

All metal elevators follow conventional design practice, with a stamped flanged spar, rounded metal leading edge shrouded into the stabilizer trailing edge, and stamped flanged ribs. The trailing edges are formed simply by crimping the skins together and riveting—with ordinary rivets as is the case with the rudder.



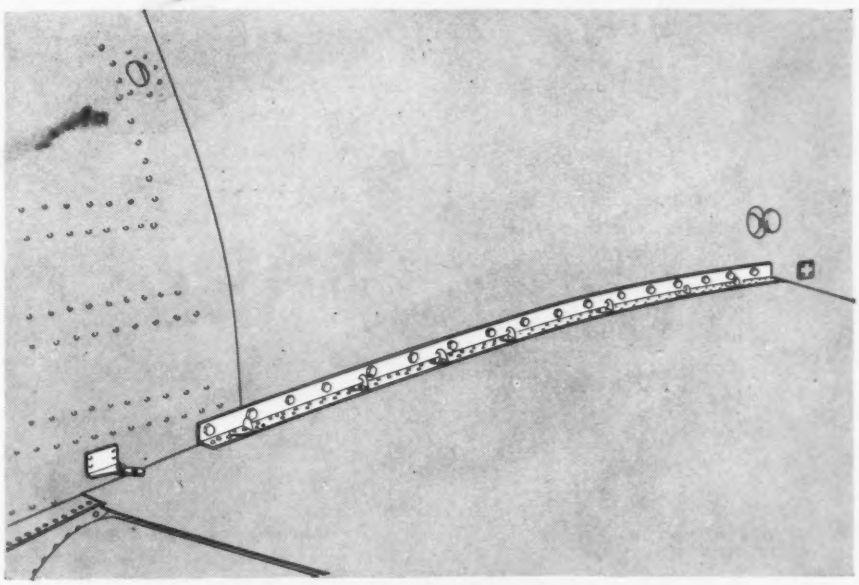
Wing-to-fuselage attachment inside left nose rib, showing bolt through fitting which is attached to bulkhead forming aft end of front main fuel cell.

Outboard hinges are self-aligning ball bearing units, set just outside the large mass balances at the tips, while the center units are of similar type set just beneath the vertical fin.

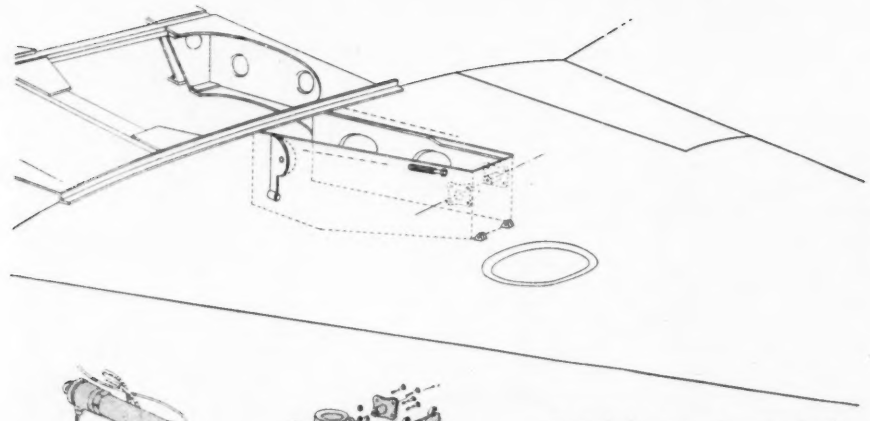
Both elevators have 27 x 2½ in. mass balanced trim tabs set near the inboard end. These tabs were apparently designed as interchangeable servo units, for a small arm at the outboard end extends up from the right one and down from the left, and captured enemy documents show an anchoring arm designed into the stabilizer trailing edge. However, the operational experience or Allied bombing made completion of this plan impossible, for the tab arms were not connected to the stabilizer and, in fact, the tabs had been riveted into immobility by small gusset plates at each end. Nevertheless, each tab had four hinges, with ball bearing units at each end and pins through yokes for the two in the middle. As is the case with the rudder trim tab, the trailing edges of the tabs are nicely flush riveted.

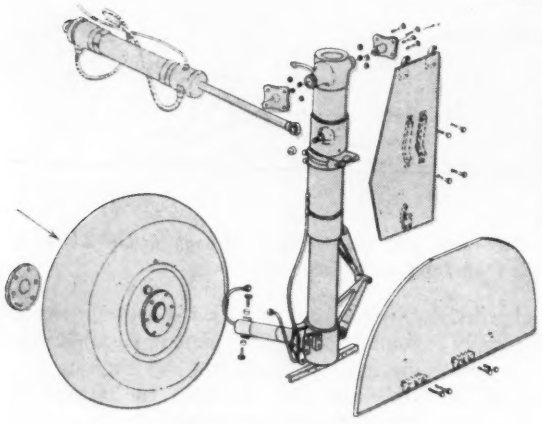
One-piece pressed-aluminum stabilizer fillets are held in place by a leading edge pin which moves up and down between greased strips riveted to metal brackets just above the adjusting jack, and by screws—one top and bottom—10 in. aft of the stabilizer spar.

There are many interesting varia-

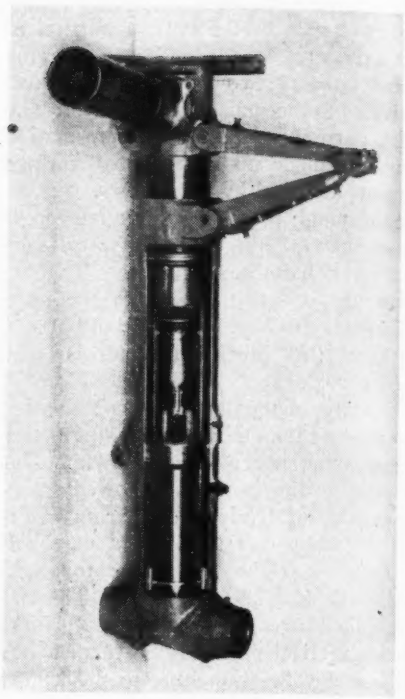


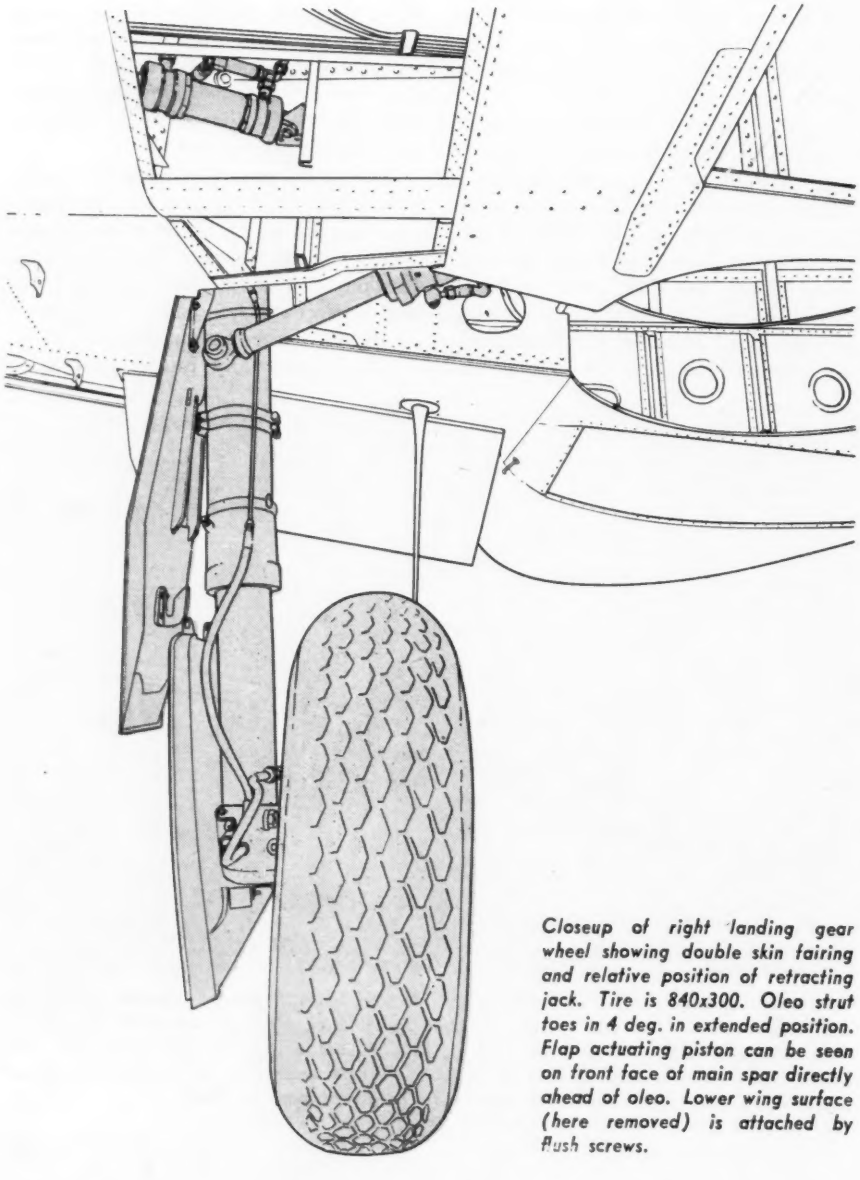
Principal wing-to-fuselage attachment is by 17 bolts through flanged member riveted to top wing surface. On first Me-262 brought to America for tests many of these holes were elongated and some were as much as 1/16 in. out of line, so extra steel strip was added, holes being reamed to take ⅞ in. bolts. Angle bracket at left is anchor for fillet cable which goes under slips seen riveted to horizontal part of flange.





Exploded view of main landing gear and phantom sketch of wing showing position of landing gear torque box and wheel well. Cutaway (right) shows main landing gear oleo strut with hinge bearings and wheel axle welded in place.





Closeup of right landing gear wheel showing double skin fairing and relative position of retracting jack. Tire is 840x300. Oleo strut toes in 4 deg. in extended position. Flap actuating piston can be seen on front face of main spar directly ahead of oleo. Lower wing surface (here removed) is attached by flush screws.

tions in both design and workmanship in the 262's wing which, though approximately like our laminar flow foils, has a plan form which is angular, to say the least. The leading edge has a 20-deg. sweepback; the spar sweeps back 12 deg., starting at the fuselage side; the trailing edge sweeps forward $8\frac{1}{2}$ deg. to the outboard side of the power plant; then sweeps back 5 deg. from there on out. All this and 6 deg. dihedral, too.

The wing is built around a composite I-beam main spar having steel booms and built up dural web, tapering in depth from $14\frac{1}{2}$ in. at the centerline to 3 in. at the tip attachment fitting. Spar boom caps are $\frac{3}{4}$ in. thick at the centerline, the upper being $4\frac{1}{4}$ in. wide, the lower $4\frac{3}{4}$.

Built in two sections, the spar is spliced at the centerline where the webs are flanged and bolted. Steel splice plates, $\frac{3}{4}$ in. thick by 8 in. long, go over both the top and bottom of the boom caps and are held in place by six through bolts on each side of the web. Incidentally, none of these bolts were safety wired on one plane that had been accepted by the Luftwaffe. Small steel wedges are placed between the splice plates and lower caps, for the taper on that surface starts right at the centerline.

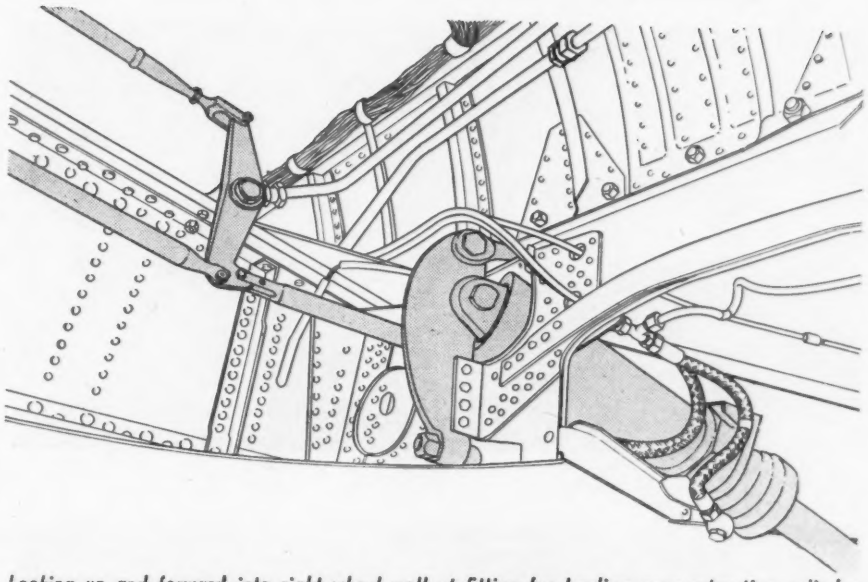
Three heavy steel hat shaped stiffeners are riveted to the front face of the spar between the centerline and fuselage skin, which is 33 in. away where the spar sweepback begins, and hat shaped aluminum stiffeners are used from there on out.

Since the spar is at about 35% MAC, nose ribs are longer than they

would be in a two-spar wing and consequently vary in construction. Compression ribs have hat shaped vertical stiffeners, others are of conventional stamped flanged construction with riveted stiffeners and holes where necessary for control connections. Two large J-section spanwise stringers are used ahead of the main spar, and one is placed between it and the auxiliary spar.

This latter structure, set 38½ in. behind the main spar at the centerline, is 12 in. deep at that point and is a channel shaped aluminum structure with hat shaped stiffeners, extending out to the wingtip to carry flaps and ailerons.

The top skin of the wing, varying from .083 at the leading edge to .080 at the trailing edge, is flush riveted except at the base of the leading edge where it is flanged out and riveted to the bottom surface. Here, however, a rolled .010 sheet steel section is riveted in place to give a true airfoil behind the slots.



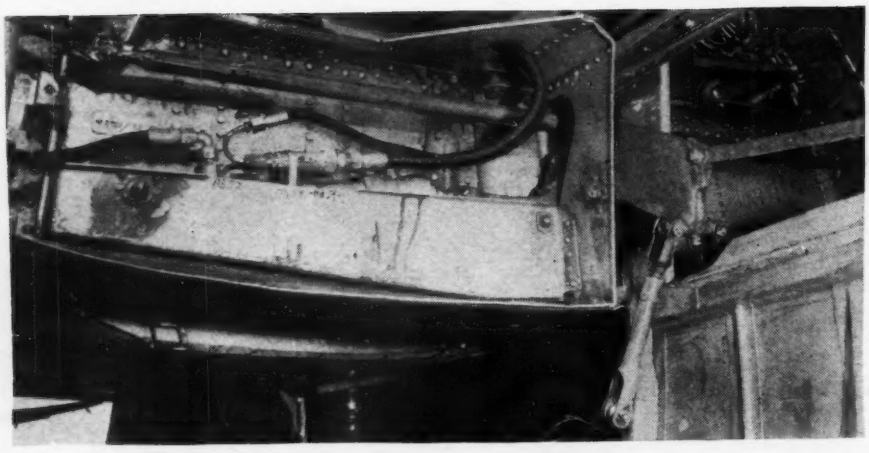
Looking up and forward into right wheel well at fitting for landing gear retracting cylinder, which is attached to root rib. At upper left, attached to main spar top boom, is aileron bell crank showing difference in size in push-pull rod from control stick (top) and those extending to ailerons (bottom). Above retracting cylinder fitting can be seen self-locking nuts attaching fuselage skin to flange on upper wing surface.

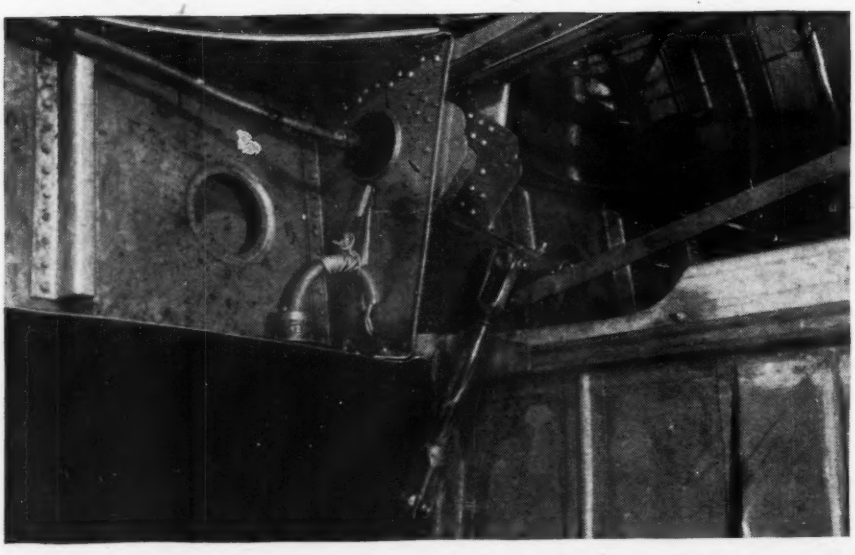
These units, with .040 steel skin, extend from the fuselage line 40½ in. to the power plants, and from there to the wingtips, the outer segment being built in two sections of 77½ and 48½ in. lengths connected by a ½-in. long steel pin.

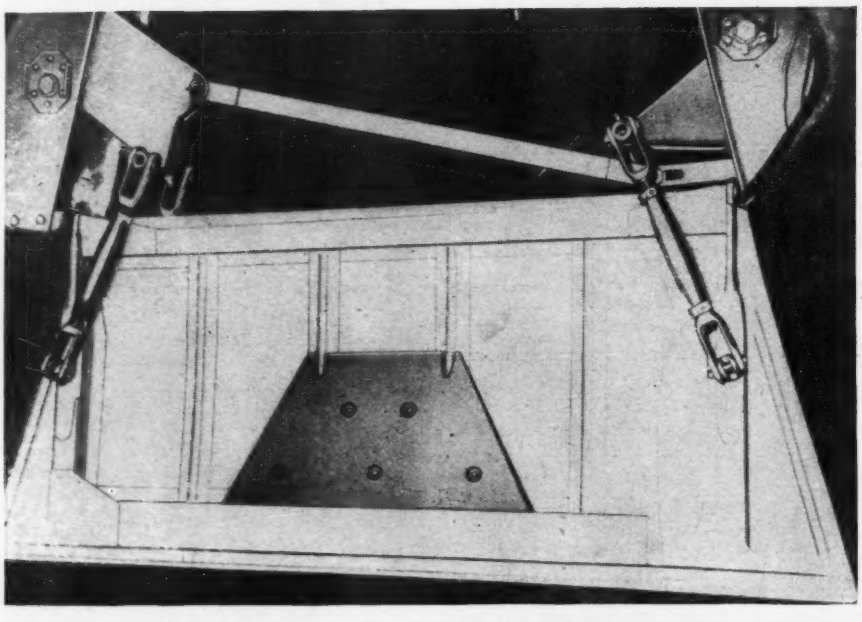
Each segment is bolted to two curved steel guide tracks which slide over ball bearing rollers bolted to wing ribs. Travel of the slots is a maximum of 6 in. at the inboard end and 2⅝ in. at the tip. The slots open automatically at 186 mph. in gliding angle and at 279 mph. in a climb.

The 5¼-in. wingtip, with its integral formation light set in a transparent plastic covering, is built in two halves, flush riveted to an inboard rib and spar. The two halves are welded together around the outer edge and, on at least one craft, a thoroughly sloppy weld it was. Its method of attachment, however, is neat and can be accom-

Looking up and aft into main gear wheel well. Seen are centerline fairing doors, which serve as landing gear uplock, and construction of auxiliary spar will be noted. Just above this spar can be seen bottom part of cylindrically shaped cockpit liner, a unit designed for pressurization but unused in this way. Opening in front of main spar takes 53-gal. reserve fuel tank.







Top photo, made from left main wheel well, shows fairing door operating cylinder fitting on aft face of main spar at left center, with universal joint connection to box-type bell crank which is, in turn, universally-connected to fairing doors, corner of which is shown at lower right. Flat tie rod on upper corner of bell crank is connected to crank, which distributes power to aft end of doors, details of which are shown in center photo. Connecting linkage here is bolted to box-type structure attached to front face of auxiliary spar. Lower photo is of German perspective sketch, showing how unit was designed.

plished fairly fast with simple tools.

A horizontal pin near the leading edge slips into a holed angle plate on the wingtip rib, then the tip is pushed toward the planes so that an angle bracket slips into a forged fitting riveted to the end of the spar, whereupon a through bolt with self locking nut is pushed down from the top through small access holes. At the time the tip is pushed toward the wing, a vertical plate slips into a yoke attached to the end of the auxiliary spar with the result that a three-way fastening is obtained with only one bolt being necessary.

All metal ailerons are of conventional design, having a channel-section aluminum spar, rolled sheet aluminum leading edge, and stamped flanged ribs. At the trailing edge the two skin surfaces are crimped and riveted to a flat $\frac{3}{4}$-in. strip. Here, as on the rudder and stabilizer, the rivets are not flush.

The ailerons are built in two sections. Each have a 42-in. span, and the two sections are connected via the control bracket, which is split so that one half is riveted to the outboard rib of the inner section, the other to the inboard end of the outer section. A self-aligning ball bearing hinge also serves as a connecting point for the two sections, and similar bearings are bolted to ribs aft of the auxiliary spar at each end.

Evidently the $38\frac{5}{8}$ x 3 in. trim tabs were originally proposed as servo tabs, but in practice they ended up only as ground-adjustable units, for the control arm, riveted to the outboard end of the inner aileron section, is attached by a turnbuckle rod to the aileron-operating bracket rather than being attached to the wing to give the servo action.

Unlike the elaborate hinge points provided in the rudder and elevator trim tabs, those on aileron tabs are simply straps bolted to the aileron and hooked around pins in the tab. Like those on the other tabs, however, the trailing edges are neatly flush-riveted.

Flaps are built in two sections: The inboard (which has a $21\frac{3}{4}$-in. chord) extending $38\frac{1}{2}$ in. from the wing root to the power plant, and the outer section extending $48\frac{3}{4}$ in. from the power plant. With rolled aluminum leading edges, stamped channel-section spar, and conventional ribs, they are built in two halves, bolted together except at the trailing edge where the skin surfaces are crimped and riveted (with brazier head rivets) to a $\frac{1}{2}$-in. aluminum strip.

Ball bearing rollers at both ends of each section run in 7-in. steel guides which are bolted to the auxiliary spar so that, in operation, the flaps move

back and down, for the guides slant down 35½ deg. from the top to the bottom wing surface. This action is imparted by hydraulically operated toggles which force the flap bodily aft approximately 5½ in.—and down because of the guide—except for the final 5 deg. of flap action, which is a pivot movement. The upper wing surface extends out over the flap so that even when extended to the full 50 deg., the flap leading edge is shrouded for 1½ in.

The flap actuating cylinder is set at a 45-deg. angle to the front face of the main spar directly ahead of the oleo hinge point and is attached to one corner of a triangle whose apex is its hinge point on the spar. Where the piston attaches there is also attached a push-pull rod which extends across the plane to the left to a bell crank set just over the left power plant, with a push-pull rod going straight back to the aft face of the auxiliary spar. Here it is connected to an arm extending down from a torque tube connected to the toggles which force the flaps back and down.

Right side flaps are actuated by a tube going straight back from the base of the triangular member connected to the actuating piston.

Pilot error in forgetting to lower the landing gear is avoided through the system being so arranged that the flaps cannot be extended until the landing gear has been put down.

The left outboard flap on the craft examined has markings at 0, 10, 20, 30, 40, and 50 deg., with the 20-deg. mark in red for takeoff.

Three of the lower wing skin panels, extending over three ribs each, are held in place by flush screws placed approximately 1½ in. apart. While the primary purpose may have been to facilitate access, the small number of units requiring maintenance gives rise to the belief that it may have been employed to facilitate production by eliminating blind riveting.

Quite an unorthodox method is used to attach the wing to the fuselage. Near the base of the root nose rib, 9 in. aft of the leading edge, a 1-in. bolt goes through a two-sided forged bathtub fitting which is bolted to the aft face of bulkhead backing up the front fuel cell. A similar sized bolt is used on the root rib aft of the auxiliary spar. Then, riveted to the top wing skin at the fuselage line is a $1\frac{3}{16}$ x $1\frac{3}{16}$-in. steel angle member through which 17 bolts and self-locking nuts attach it directly to the fuselage skin.

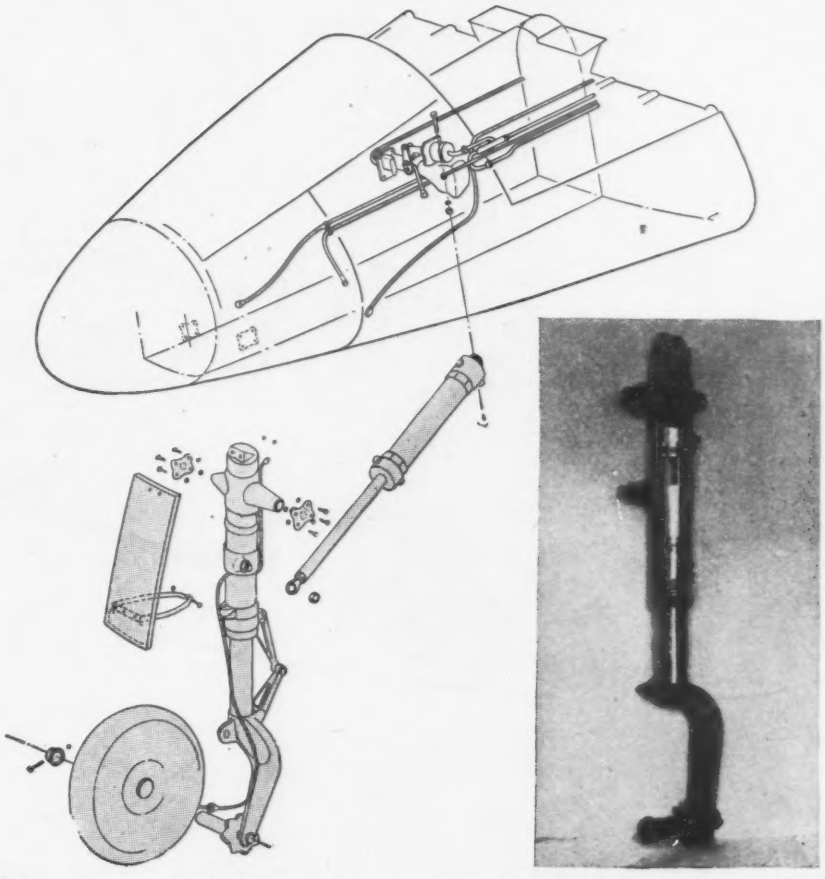
On the first Me-262 brought to this country for study, many of the holes in the fuselage skin had been elongated and some were as much as $\frac{1}{16}$ in. out of line. When the craft was being prepared for flight tests, the holes were reamed to take $\frac{7}{8}$ in. bolts and an additional steel strip was used to back up the vertical half of the angle member.

The wing fillet, just over 73 in. long, is held in place by a cable anchored to an angle bracket at the trailing edge and going under seven hooks riveted to the attaching angle-member, with a turnbuckle at the front keeping it snug. The fillet around the leading edge is a drawn light aluminum alloy section attached by eight flush screws.

Oleo struts for the main wheels of the hydraulically retractable tricycle landing gear are hinged in a built-up steel box structure on the end of spanwise spars extending 30 in. from the root rib midway between the main and auxiliary spars.

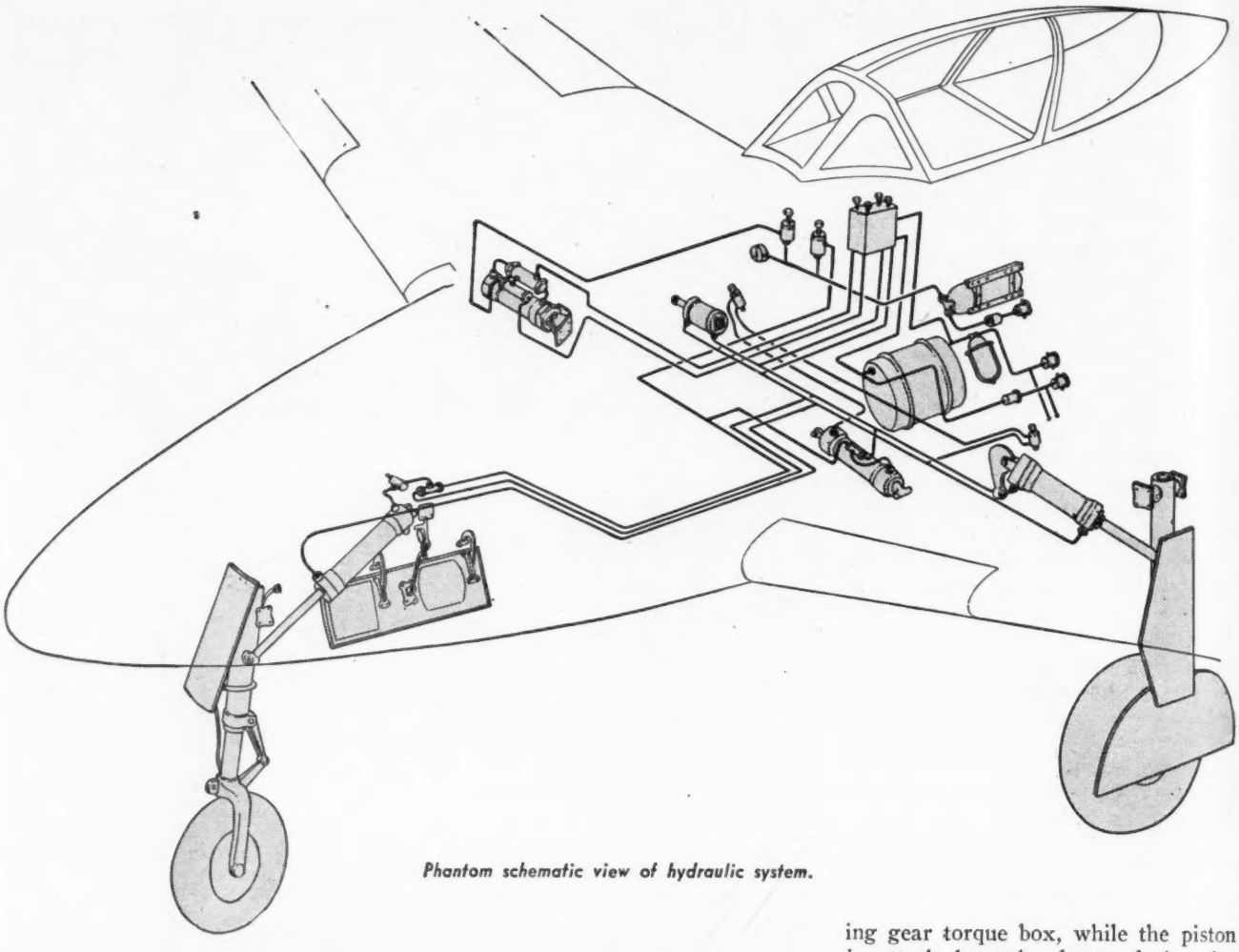
The 26-in.-long forged oleo strut is 5⅓ in. in dia. and has conventional torque scissors on the aft side designed for a 20-in. piston travel. In preparing the craft for flight tests it was found that the main wheels had considerable lateral play, but when the normal 1,200 lb. pressure was built up, the wobble disappeared.

The retracting jack is bolt-hinged to a steel fitting bolted to the root rib at the end of the front spar of the land-



Phantom view showing installation of nose landing wheel, which is depicted in exploded view. Inset is cutaway of nose wheel strut. Note that original plans called for conventional torque scissors, however, late model 262's had built-in shimmy dampers.

Looking aft and up into nose wheel well at retracting cylinder attachment. As nose wheel retracts it strikes tubular linkage to pull and lock fairing door closed.



Phantom schematic view of hydraulic system.

Quickly removable cover for hydraulic reservoir filler, a unit very similar to many used on Focke-Wulf 190. Four of five of these units on Me-262 are interchangeable, but the fit in some cases was so bad that doped fabric strips had to be added, as is evident here.

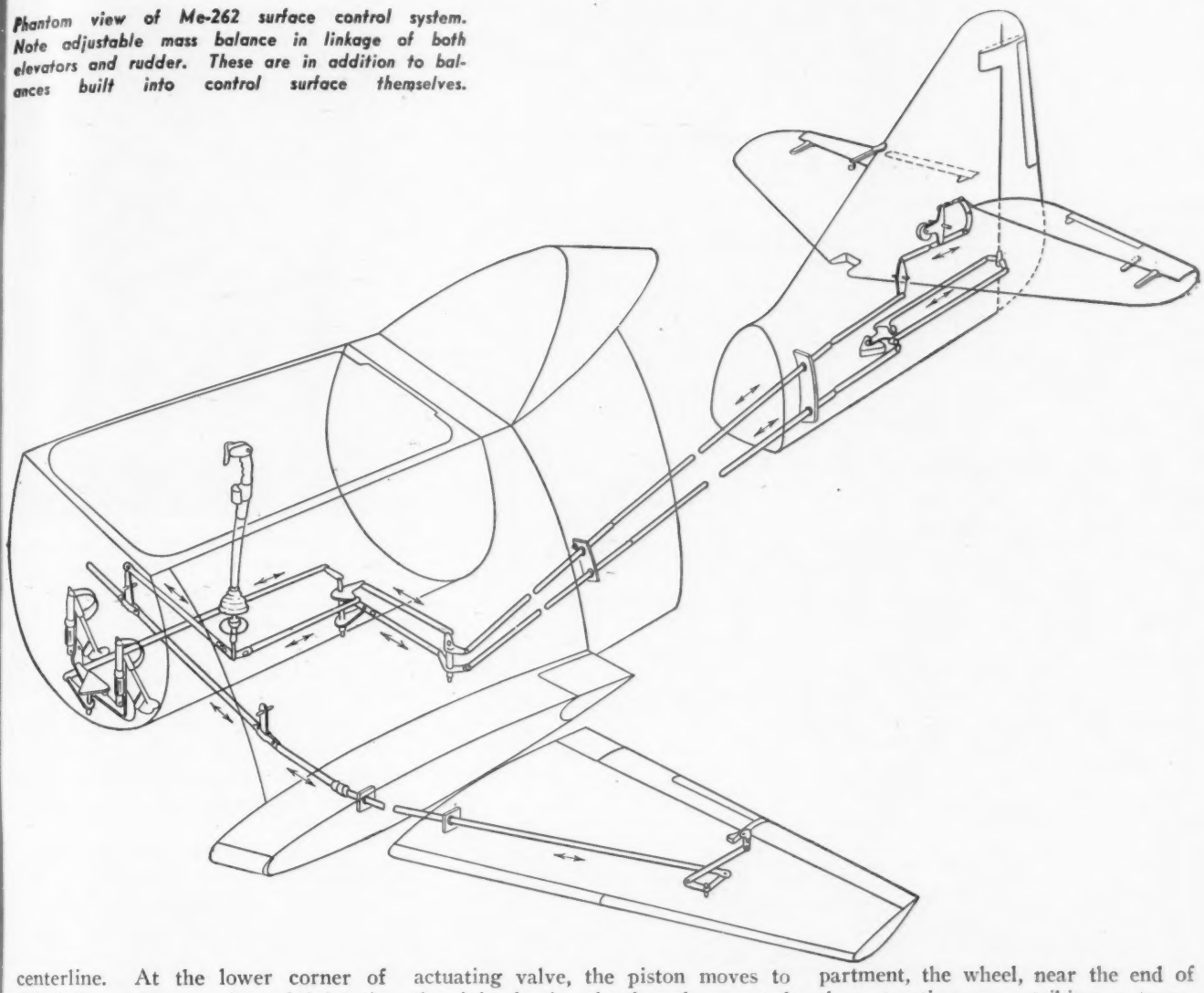
ing gear torque box, while the piston is attached to the front of the oleo strut by a ball and socket joint.

Fairing for the main gear is built in two sections, both of which are double-skinned grid-type structures with the top section hinged to the torque box end and the lower bolted to a bracket welded to the oleo piston just above the axle.

In operation the main wheels swing up and into the bottom of the fuselage, with the right strut operating an actuating valve at the end of its arc. This valve in turn closes fairing doors which are hinged at the fuselage centerline and which serve as the landing gear up lock.

To accomplish this, a hydraulic cylinder is attached parallel to the aft face of the main spar just to the left of the fuselage centerline. Its piston is connected to a welded steel box type bell crank which, in turn, is attached by a universal joint to another box bell crank set between two stamped flanged vertical plates set along the

Phantom view of Me-262 surface control system. Note adjustable mass balance in linkage of both elevators and rudder. These are in addition to balances built into control surface themselves.



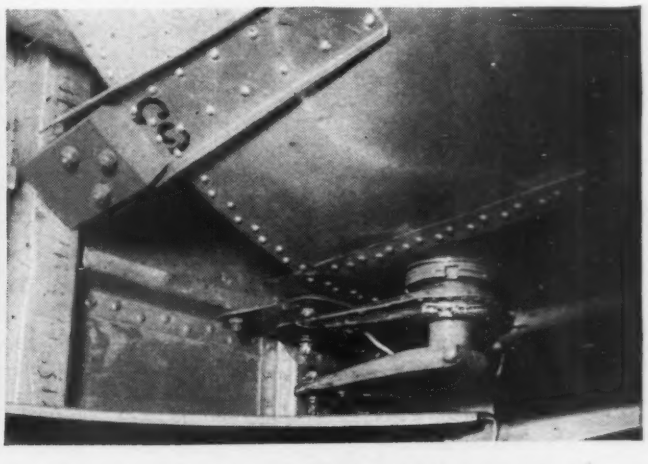
centerline. At the lower corner of this bell crank are universal joint tie rods connected to the leading edge of the built-up fairing doors, and at the upper rear corner is a flat steel tie rod connected to a triangular shaped built-up bell crank attached to similar tie rods on the trailing edge of the fairing doors.

Thus when the oleo strut hits the actuating valve, the piston moves to the right, forcing the tie rod-connected bell cranks to snap the doors closed under the wheels, with the 90-deg. change in direction between the units serving as the locking mechanism after the hydraulic pressure on the piston is relieved.

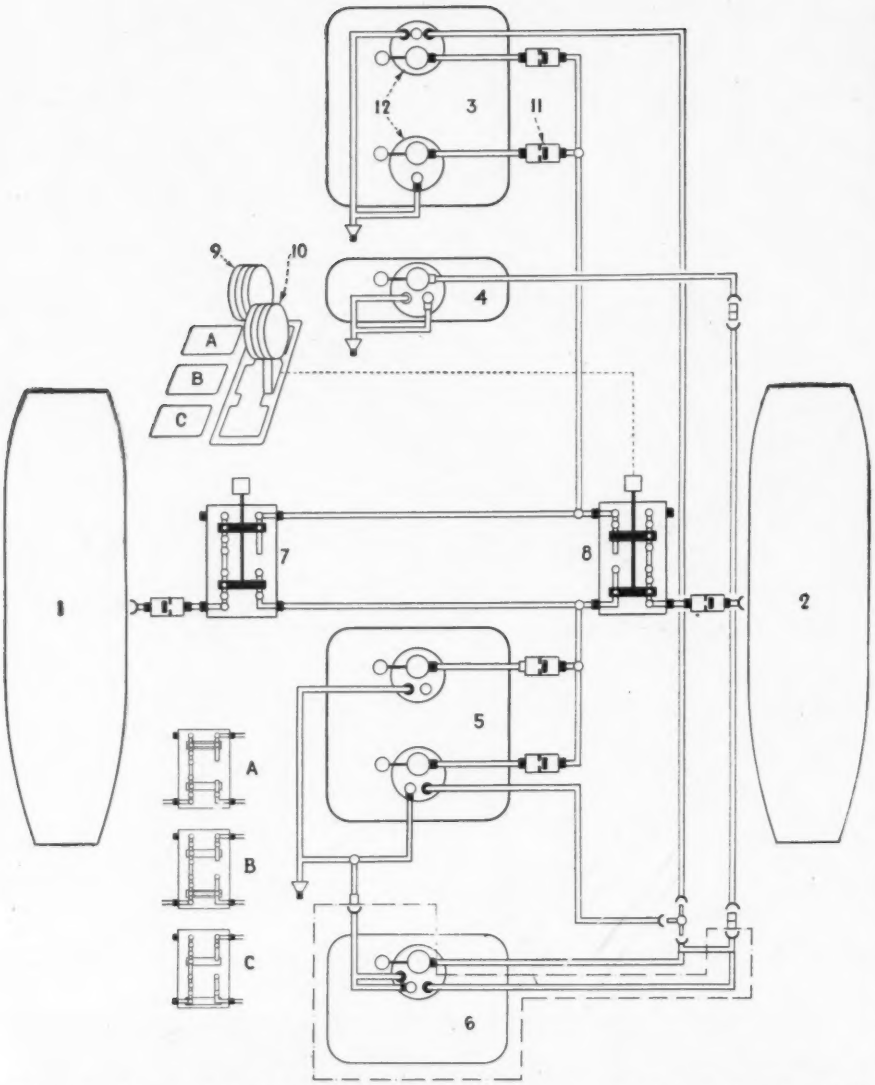
The nose wheel retracts aft and up into a well below the armament compartment, the wheel, near the end of the retracting arc, striking a transverse tube which pulls the double skin fairing door closed. Spring loaded pins moving into the piston serve as up and down locks.

German drawings studied in connection with this article show provision for the conventional torque scissors, but on the later model craft examined, the

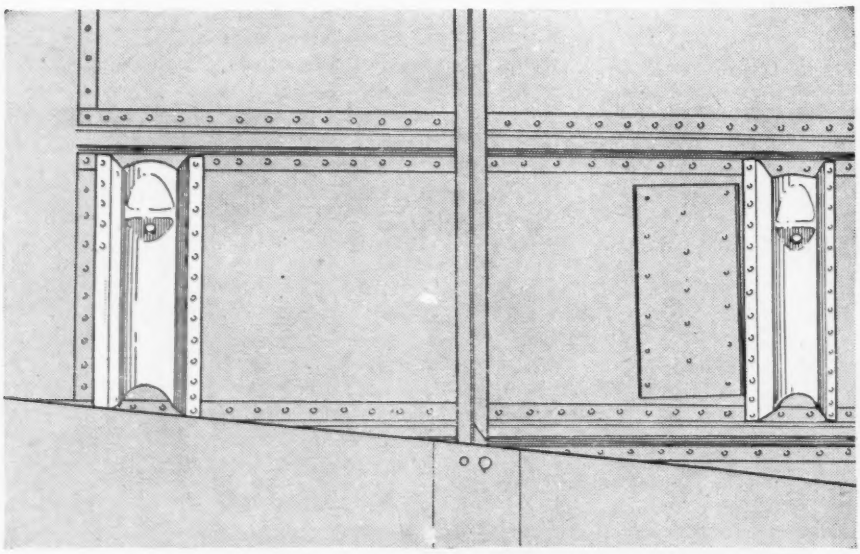
Bottom of control stick, seen extending through ball and socket joint in bottom of cockpit liner, with aileron torque tube extending to right and elevator tube extending aft.



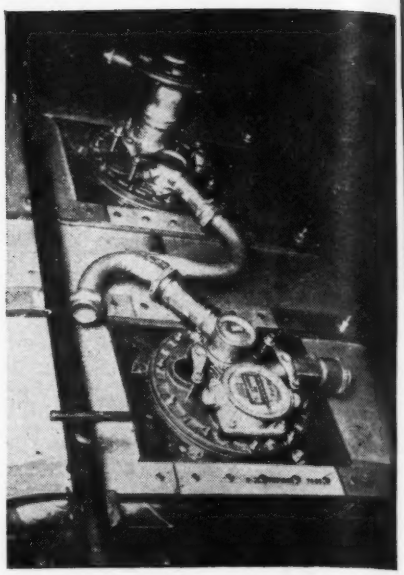
Elevator bell crank and trim tab (unused because trim tabs were riveted to elevators) over auxiliary spar attached to bottom of cylindrical cockpit liner.



Schematic diagram of Me-262 fuel system showing: (1) and (2), left and right engines; (3) fore fuel tank; (4) auxiliary fuel tank; (5) aft fuel tank; (6) extra auxiliary tank; (7) and (8), valves for left and right power plants; (9) and (10) left and right engine safety petcocks; (11) reverse valve; (12) fuel pumps. Craft studied lacked extra auxiliary tank (6), and reports from abroad indicate Germans were unable to get this modification into more than few planes before their defeat.



Inside rear fuel cell showing pressed fittings between stringers to which fuel cell is bolted for suspension. Front bulkhead in this section is aluminum alloy supporting rear armor plating, and aft web is sheet steel. Plywood buffer sheet at bottom is screwed in place.



Top of one of two 238-gal. main cells showing installation of two booster pumps, plywood covering, and supporting straps.

nose wheel contained a built in shimmy damper. The nose gear retracts and extends after the main wheels have been locked either up or down.

Both landing gear and flap operating systems have connections with a compressed air bottle which can be cut in for emergency operation of the two systems.

Surface controls present several odd and interesting features. The control stick, for example, is mounted in a ball and socket joint set in the bottom of the cockpit liner, extending down 4 in. and ending in a welded angle bracket. Attached by a ball bearing joint to one face of this bracket is a $\frac{3}{4}$-in. tube extending to the right above the main spar. Just inside the fuselage, and bolted to the top boom of the spar, is a bell crank from which 1-in. push-pull tubes extend, with one universal joint in each at the fuselage side (to compensate for spar sweepback) out to bell cranks set just ahead of the aileron control arms.

Attached to the aft face of the angle bracket on the stick is a $\frac{5}{8}$-in. elevator operating tube going aft to a self aligning ball bearing bell crank set just over and ahead of the auxiliary spar, from which a 1-in. tube extends to the left side of the fuselage and another bell crank to connect to a similar sized push-pull tube going aft. A third bell crank is set in the empennage near the stabilizer leading edge. Extending straight aft from this crank is another push-pull rod connected to the elevator horn and, just ahead of the horn, a large mass balance which can be ground adjusted on the fulcrum.

This balance is in addition to those already noted as being set in the eleva-

tors themselves, and may be a late modification. Reports from abroad have indicated that at speeds over 500 mph. the ailerons and elevators of the 262 become extremely hard to move and that an extendable control stick designed to give increased leverage had been developed. However, no such stick, or provisions for its installation could be found on the craft studied, and it is held possible the mass balance just discussed has been utilized in its stead.

Rudder pedals are very similar to those on the FW-190, incorporating the main wheel brake pedals as integral units. A torque tube extends aft from the right pedal inside the cockpit liner, then through a seal to a bell crank where another tube extends to the left side of the fuselage to a second crank which is connected with the push-pull tube extending to the empennage, where a third crank, with adjustable mass weight, is connected to double tubes connected to the enclosed rudder horn.

The fuel system consists of two 238-gal. main tanks plus a 53-gal. reserve and, at least in design plans, an auxiliary tank of about 170 gal. capacity. Both self-sealing main tanks have plywood coverings and are suspended by two straps on the ends of which are bolts that go up through pressed fittings riveted to the inside of the fuselage skin about two-thirds of the way up the side. Nuts are put on the bolts through access holes in the fuselage skin, with the holes covered by doped fabric patches.

Each of the main fuel cells has two booster pumps and the reserve tank has one, the system being so arranged that fuel can be pumped from any tank to either engine, or fuel from the rear tank can be pumped to the front.

The reserve tank (at least some of these have not been self sealing) goes just in front of the main spar. It is trapped to a single-skin panel, 19¾ in. deep by 66¼ in. wide, that is reinforced by six hat shaped stiffeners and is attached to the fuselage by flat screws placed approximately 1¾ in. apart.

Evidence of the Nazi's attempts to get more range out of the Me-262 is shown by plans for installation of the 170-gal. auxiliary tank aft of the rear main cell. It is not known how extensively, if at all, this plan was carried out, for the craft studied was the latest model produced and it had no such installation. Instead, the radio was installed in the space and, a little farther aft, the master compass and oxygen bottle. Access to these units is via a 17½ x 15¼-in. door held in place by four quick fasteners.

Radio installation consists of the usual German equipment—FuG 16Z or FuG 16 ZY (VHF R/T, D/F and retransmission facilities for ground control stations) and in some cases IFF has been installed.

Whether Hitler was finally convinced that the Me-262 was not the world's hottest bomber or whether the Luftwaffe went ahead in the face of his orders is not known, but one final modification of the craft—the Me-262 B2—was in the works when the Germans capitulated.

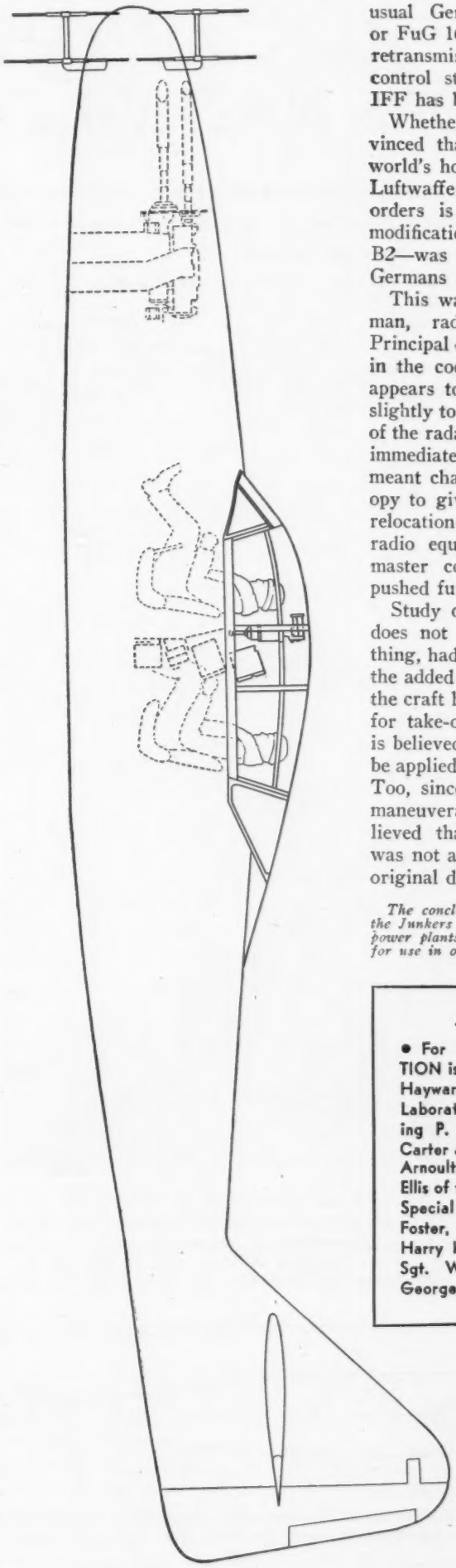
This was to make the plane a two-man, radar-equipped night fighter. Principal changes necessary were made in the cockpit, where the pilot's seat appears to have been pushed forward slightly to help make room for addition of the radar operator's screens and seat immediately behind. This, of course, meant changing the design of the canopy to give the necessary length, and relocation of the aft fuel tank, normal radio equipment, oxygen bottles and master compass, all of which were pushed further aft in the fuselage.

Study of the plans for this change does not indicate that much, if anything, had been done to compensate for the added weight aft of CG. and, since the craft had to be trimmed nose heavy for take-off as originally designed, it is believed that even more trim had to be applied for the night fighter version. Too, since the 262 was not the most maneuverable to begin with, it is believed that the radar-loaded version was not as good a combat craft as the original day fighter version.

The concluding part of this study will cover the Junkers Jumo 004 gas-turbine jet-propulsion power plants, used in the ME-262 but designed for use in other craft as well.

ACKNOWLEDGMENT

• For unusual cooperation, AVIATION is deeply grateful to Col. J. M. Hayward, Chief, Technical Data Laboratory, ATSC, and to Capt. Irving P. Brown, Chief, Capts. W. H. Carter and H. R. White and Lts. J. E. Arnoult, F. D. Van Wart, and Bernard Ellis of the Foreign Equipment Branch. Special thanks are due Sgt. Robert Foster, Hangar Chief; Staff Sgt. Harry Kirkpatrick, Crew Chief; Tech. Sgt. Warren Stoddard; and Sgts. George Ledbetter and Wilfred Vigor.



Phantom view showing final modification—the Me-262-B2—a two-man radar-equipped night fighter. Addition of extra seat meant moving fuel tanks, radio and other equipment farther aft in rear fuselage section.

U. S. AUTOJET TOPS NAZI V-1 ENGINE

Tests show that American-designed impulse-jet has performance and weight characteristics superior to those of German unit. Speedier firing rate is engine's prime feature.

AN AMERICAN-DESIGNED impulse-jet engine, stated to surpass that used on the Nazi Fiesler Fi-103 V-1 flying bomb, has been developed by G. M. Giannini & Co., of Pasadena, Calif.

In conjunction with the AAF, complete tests have already been run on many sizes and models of the new propulsion unit. A small wind tunnel model has been built which develops 2 pounds-thrust. This capacity is only .004 the rating of the V-1 unit, yet it is superior, pound for pound, to the German unit. The little engine is only 2 ft. long, and about 2 in. in dia. It is made of aluminum alloy and stainless steel, and weighs but 5 oz.

Set upon a stand for indoor operation, this model has a separate fuel tank connected to the needle-valve-controlled fuel inlet near the engine's front orifice. A small sparkplug in the unit's combustion chamber is used only in starting, since after the combustion chamber has been sufficiently heated, the engine continues to fire automatically.

Entering the mouth of the engine is a small pipe, used to send a blast of compressed air past the needle valve and so start initial vaporization of the liquid fuel (gasoline, kerosene, or the like). The blast also induces a flow of gas and air, and as soon as the firing cycle begins, an intake draft is started by the vacuum created through the explosions. The auxiliary air tube is then withdrawn so as not to disturb the free flow of air into the engine.

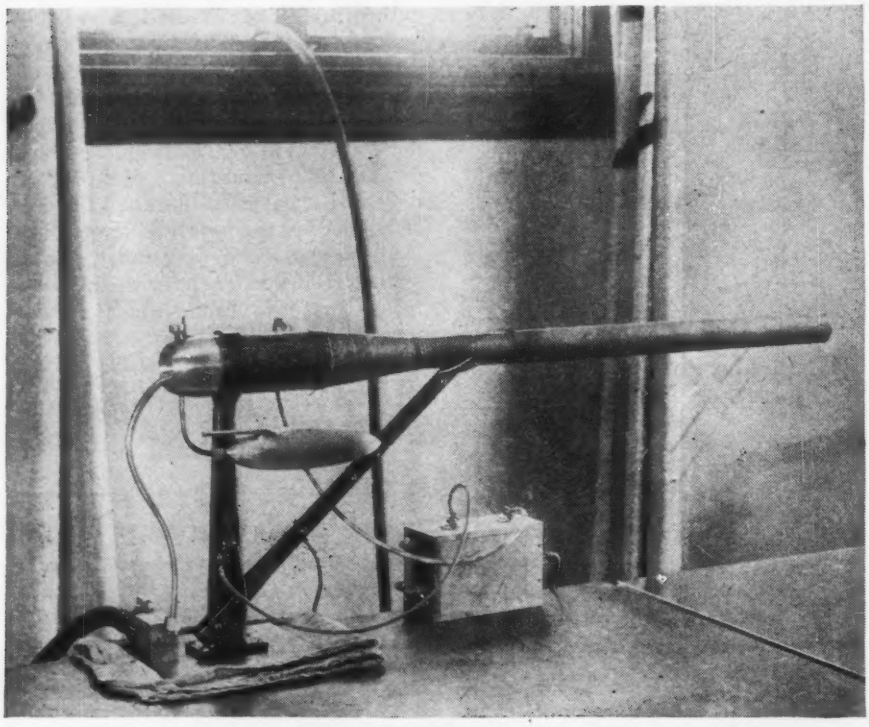
Efficiency of the diminutive power plant is said to be so great that if a fuel tank were directly attached and the engine started off on an inclined plane it would continue to fly through the air, even without wings, until the fuel was exhausted.

Specifically, company engineers claim greater efficiency for the engine over the German type because of more thrust, less weight, and smaller size. More power is developed because the American engine fires more than five times faster than the German unit. The wind tunnel model, for instance, fires approximately 250 explosions per second, when operating at full throttle.

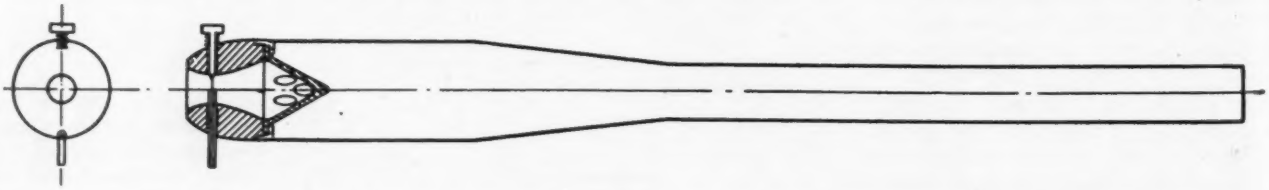
One of the problems yet to be solved in jet engine construction, states Company Engineer A. J. Klose, is practical sound control. It is pointed out that attempts to use mufflers have thus far resulted in great loss in efficiency.

It is believed that present day impulse-jet developments only make such a power plant practical for aircraft traveling at over 500 mph.

Design of the new engine was carried out by A. J. Klose and W. B. Goodman, of the company, after careful study of captured V-1 power units.



Wind tunnel model of new Giannini impulse-jet propulsion unit set up and ready for operation. Only .004 capacity of Nazi V-1 unit, it is said to develop 2 pounds-thrust and, if launched, to be able to fly without wings. Streamlined fuel tank may be noted just below engine, and mounted on table (right) is box containing switch-operated electric coil connected to miniature sparkplug in engine's combustion chamber.



Giannini wind tunnel model engine in cross section. Construction is of aluminum alloy and stainless steel, and weight is but 5 oz. Improved engine was developed after analysis of captured Nazi V-1 propulsion engines.

Landing Analyses For Flying Boats and Seaplanes

PART I

By ERNEST G. STOUT, *Staff Engineer in charge of Hydrodynamics, Development Design Staff, Consolidated Vultee Aircraft Corp.*

"Must come down" gets the accent in the platitude about "everything that goes up"—and with marine aircraft an extra accent is warranted. For, taken alone, satisfactory static and takeoff characteristic don't tell the whole story of a new plane design . . . First of a series analyzing rough water, impact, and skipping factors.

Most aeronautical engineers and designers of seaplanes and flying boats are primarily interested in the static and takeoff characteristics of a new design, hence they often feel that the work of the hydrodynamicist ceases when these characteristics are successfully demonstrated.

However, events in recent years have clearly indicated that the designer—not only of seaplanes but of landplanes as well—must have a thorough understanding of the landing phenomena if he hopes to have a completely satisfactory craft. But, because of the emphasis placed on statics and the takeoff characteristics, little literature is available to the engineer on the landing functions and the method of their analysis. Several of the more important considerations with methods of solution are outlined here.

The landing phenomena can be readily resolved into three fundamental considerations:

1. Rough water analysis—includes the technique of landing seaplanes or ditching landplanes in rough seas, and the analytical treatment of this complex operation.

2. Impact integration—a mathematical analysis developed by the author to assist the designer in isolating various design parameters and in gaging their isolated effect on landing impact.

3. Skipping analysis—a most important and sometimes disastrous form

of dynamic instability encountered frequently during landings by otherwise completely satisfactory flying boats or seaplanes.

The latter two items are primarily smooth water functions and readily lend themselves to analytical treatment. Rough water analysis, on the other hand, is extremely complex, and because of its hazardous nature it is difficult to accumulate an adequate background of accurate full-scale information. Almost invariably, the most valuable cases for study result in total loss of equipment and factual data. The analysis presented here overcomes this feature, to a great extent, by providing an analytical system completely independent of the subject airplane.

Rough Water Analysis

Requirements: Rough water requirements for seaplane design are subject to wide interpretation because of the extreme variance in encountered conditions, and technically, there are loose and inaccurate definitions. Practically, a seaplane's greatest attribute and justification is its ability to take advantage of the great expanses of sea and waterways which cover four-fifths of the earth's surface. Hence, prime consideration should be given to its ability to encounter seas of any reasonable magnitude and, particularly, its ability to land safely and remain afloat in such seas.

The dangerous argument—repeatedly proposed by some seaplane designers—that landplanes are not designed to alight in ploughed fields, and therefore, why should the flying boat be handicapped by the rough water requirement, tends to make the flying boat a direct competitor of the landplane, usually to the disadvantage of the former. The practical designer, therefore, will design his airplane to fulfill, in the most satisfactory manner possible, the requirements for the field in which the seaplane excells, and for which there will always be a great demand, thus leaving to the landplane those functions for which it is best suited. Assuming, then, that adequate seaworthiness will be placed high in the considerations of the seaplane designer, a brief discussion of the factors involved are presented.

As stated previously, rough water has been loosely defined, and has been generally applied to seaplanes as a wave, resulting from wind, with an amplitude of 4½ ft. from crest to trough. The definition is purely arbitrary and has been applied generally to all seaplanes because experience has shown it to represent, in the majority of cases, the most severe condition. This is not, however, entirely because of the amplitude of wave selected, but more because of the wave length that accompanies this amplitude.

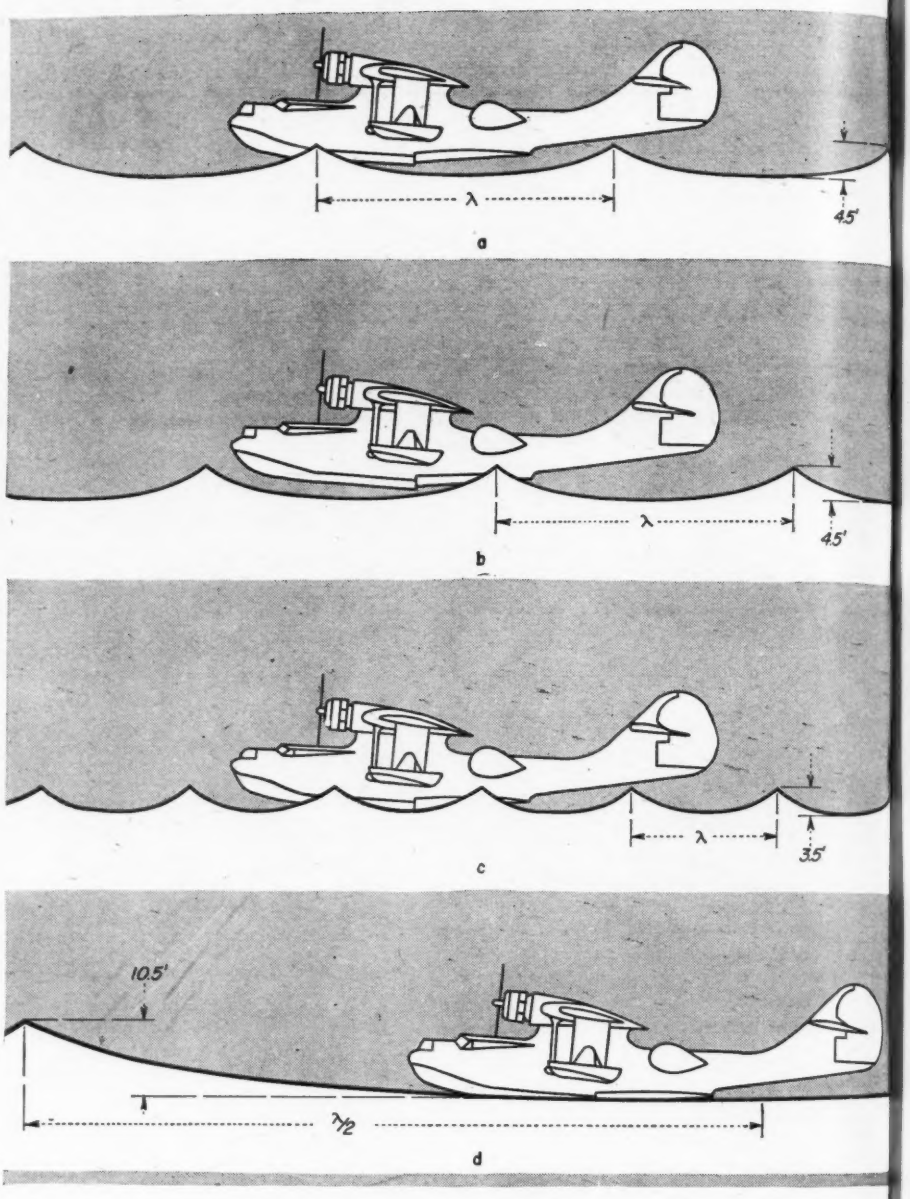


Fig. 1. Relation of wave length and position to hull length.

The length of hulls—except for small float planes—did not vary widely in the 20 yr. period after World War I, during which time this experience was being accumulated, and these airplanes received their most severe rough water pounding in seas where a crest and a trough occurred simultaneously along the bottom (shown at a and b in Fig. 1), tending to impose severe rotational accelerations.

If the wave length is such that two or more crests are in contact with the bottom (shown at c in Fig. 1), these high accelerations do not occur, and the craft planes at its normal trim, receiving only the sharp vertical accelerations of a chop and rarely of such magnitude to cause structural failure.

Conversely, if the wave length is sufficiently long (as shown at d in Fig. 1), so that the entire bottom can be set into the trough, the craft will show marked changes in pitch relative to the horizon as it planes up and over the crest, but its trim relative to the wave surface will be normal and the high rotational accelerations will not develop. In general, within reasonable limits, the longer this trough, even with accompanying increase in amplitude or wave height, the less dangerous will be the landing, particularly if the trough is of sufficient width so that the landing can be made parallel to the crests.

With the promise of continued and perhaps rapid growth in size of flying boats, the designer would do well to look beyond this arbitrary blanket requirement and consider the specific requirements of his contemplated design in the light of probable wave lengths, rather than amplitudes, to be encountered. With this requirement in mind, the most severe condition will be a wave length of 75 to 100 percent of the bottom length. It has so happened that in the past the 4½-ft. wave produced a wave length which satisfied this condition for the airplanes in use at that time.

In substantiation of the opinion that it is not amplitude alone, are numerous recorded reports of conventional flying boats landing in waves 15 to 20 ft. in height without experiencing hull failures as a result of the initial landing. In cases of this nature the wave length is 400 to 800 ft., and it is often possible to complete the landing in one trough. This broader view of seaworthiness will result in greater flying boat utility and provide a wider margin of safety for normal operation.

Trochoidal Wave Theory: Since all observed phenomena of wave motion follow the laws of the trochoidal wave theory so closely, it has been generally accepted in the analytical treatment of wave motion. To acquaint the designer with the analytical treatment of rough water, a brief discussion of this theory is presented. It should be borne in mind that the theory assumes an ideal condition of a single series of waves. Frequently, the actual sea consists of several series of these waves superimposed on one another and frequently in differing directions.

A trochoid is the locus of a point on a circle, when the circle is rolled along a straight line. If this base line is above the rolling circle, the trace of the point will result in a curve that peaks at the crests and gives a long shallow trough. It has been observed that waves may be formed and made to travel along a rope, yet it is obvious that the rope itself does not travel; likewise, a floating object on a wave will be seen to oscillate in a nearly vertical plane while the wave travels on at a definite velocity. Hence, in true wave formation, the wave is a passage of motion and the actual elements of the water move but little in the direction of the wave.

In the trochoidal development of a wave, the rolling circle can be transformed into such a wave motion by impressing upon the point O, in Fig. 2, a backward velocity V so that the point O remains fixed and a point such as P revolves about O with a constant angular velocity ω. The locus of point P, and all such points in the revolving circle, will produce a wave formation traveling with the velocity V. The elements in the crest will move with the resulting wave advance, and those in the trough will be opposed. However, for obvious ease of analysis it will be assumed that the circle rolls along the base line BL, as shown in Fig. 2.

The trochoid P_o, P', P'', is traced by the point P of radius r, within a rolling circle of radius R, rolling on the base line BL. The translational velocity of the center of the circle, O, being V ft. per sec. The wave length λ then becomes,

$$\lambda = 2\pi R \tag{1}$$

or knowing the wave length from observation, the radius of the rolling circle, R, can be determined,

$$R = \frac{\lambda}{2\pi} \tag{2}$$

The amplitude from crest to trough, A, becomes

$$A = 2r \tag{3}$$

or from observation, the radius of the generating point P is expressed as,

$$r = \frac{A}{2} \tag{4}$$

If the initial position is O_oP_o, then θ is the angle turned through when the center of the circle reaches O and the radius r is at OP. Then $O_oO = R \times \theta$ and as P traces the trochoid, it revolves about the instantaneous center T with an angular velocity ω and PT is normal to the surface of the trochoid at P. The angular velocity is the rate at which the angular displacement θ varies with respect to the time t, therefore,

$$\omega = \frac{d\theta}{dt} \tag{5}$$

and as the linear velocity of a rotating point at any time can be found by multiplying the angular velocity by the distance from the point to the instantaneous center, the linear velocity of P is

$$v = PT \times \omega \tag{6}$$

To find the level of the free water surface, wl, the latter is drawn so that the area of the half trochoid $P'P''E$ equals the area $CDP'E$. The area of the half trochoid is,

$$\frac{S}{2} = \int_o^\pi x\,dy \tag{7}$$

and taking P_o as the origin, the abscissa x as horizontal, and the ordinate y as vertical, the coordinates of P are given by,

$$x = R \times \theta - r \sin\theta \tag{8}$$

and,

$$y = r - r\cos\theta \tag{9}$$

and

$$dy = r \sin\theta\, d\theta \tag{10}$$

Therefore,

$$\frac{S}{2} = \int_o^\pi (R \times \theta - r\sin\theta)\, r \sin\theta\, d\theta \tag{11}$$

$$= \pi R r - \frac{\pi}{2} r^2 \tag{12}$$

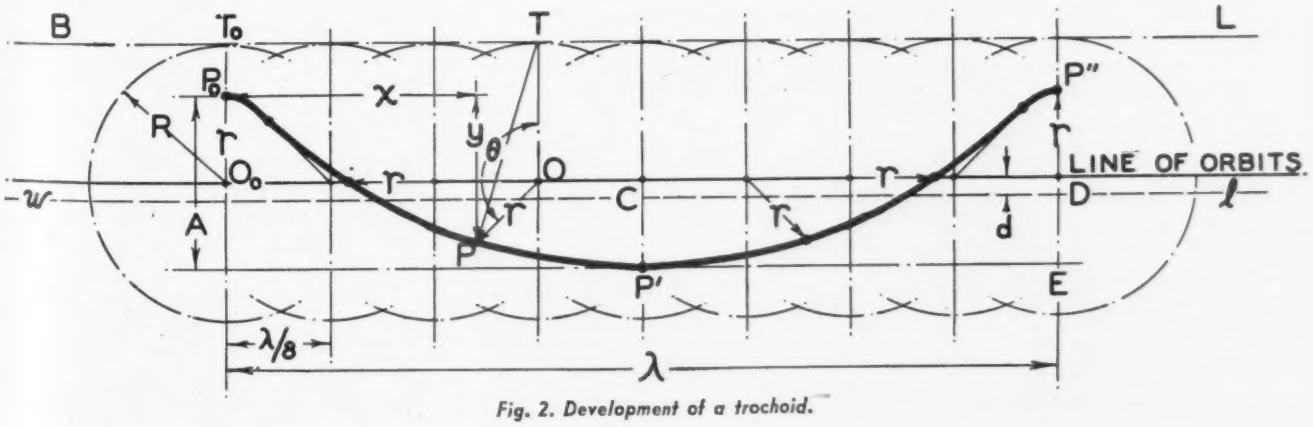


Fig. 2. Development of a trochoid.

This area must equal the rectangle $CDP'E$

$$\pi R r - \frac{\pi}{2} r^2 = \pi R (r - d) \qquad (13)$$

where d is the distance of wl below the line of orbit centers $O_o O$.
Therefore,

$$d = \frac{r^2}{2R} \qquad (14)$$

which is the free water surface from which the trochoid with orbit centers at $O_o O$ is generated.

The velocity V of a gravitational system of waves, into which class water waves fall, is independent of the density, for the same reason that a pendulum's period is independent of its mass, and this value is,

$$V = \sqrt{\frac{g\lambda}{2\pi}} \qquad (15)$$

where V is in ft. per sec. and λ is the wave length which depends upon the frequency, n, according to the customary relation where velocity is always equal to the wave length times the frequency no matter what the medium or mode of vibration may be. This relation is written,

$$V = \lambda n \qquad (16)$$

where V is in ft. per sec. and n the cycles completed per sec., a relation which is self evident. For instance, watching waves of the ocean rolling in along a pier, if we can estimate their length, λ, by comparison with a measured distance on the pier, and count the number, N, that pass per min., then their velocity is obviously λN ft. per min., or $V = \lambda N/60 = \lambda n$ ft. per sec. The expression may also be written,

$$V = \lambda/T \qquad (17)$$

where V is in ft. per sec. and the period, T, is the reciprocal of the frequency and represents the time in seconds that the length, λ, is travelled by the crest. This form is just as obvious and usually more convenient to use.

Substituting eq. (17) in eq. (15),

$$\lambda = \frac{g T^2}{2\pi} \qquad (18)$$

For roughly estimating wave lengths it is sometimes convenient to remember that the time of passing of two succeeding wave crests past a fixed point squared (T^2) multiplied by 5 will give the length very closely.

From Cornish[1], it has been established from extensive observation that on the average, the velocity of the wind in statute mph. is 2.05 times the height of the wave in ft., or

$$A = \frac{Vw \text{ mph.}}{2.05} \qquad (19)$$

where A is the wave amplitude from crest to trough and Vw is the wind velocity in mph. In open sea, in a steady wind, the velocity of the wave V is very nearly equal to the wind velocity Vw and for purposes of estimation, may be assumed equal. Using the relations shown in eq. (15), (17), and (19) in combination with the standard Beaufort's Scale of Wind Velocity, reference Table I of average wave characteristics is derived.

It will be noted from this table, that the average condition of open sea in which large flying boats may be expected to operate is a wave approximately 1/20 of the length in height. Sea waves 600 to 700 ft. in length are frequently reported during storms; however, the usual waves measure 200 to 300 ft., from crest to crest.

Landing Technique, Ditching: The landing of a flying boat or the ditching of a landplane in rough water is an extremely controversial subject, finding ardent supporters favoring varied, if not directly opposite, viewpoints. Since any rough water situation is tempered so heavily by the specific local conditions encountered, the best that can be done here is to point out some of the general considerations involved and some practices which are known to be consistently hazardous. Unless otherwise stated, the following discussion is for flying boat operation. However, the situations are similar in most respects to the ditching of landplanes, except that landing in smooth water is in itself a hazardous procedure and any degree of roughness becomes proportionately more severe in the case of land craft.

The first reaction of a pilot, forced to land in the open sea, is to head into the wind and reduce his ground speed as much as possible. What he usually fails to consider is that, unlike landing on solid ground, the water beneath him is effectively moving very nearly at the speed of the wind because of the velocity of the traveling waves (discussed in the previous section). Fig. 3 schematically illustrates a typical condition of landing upwind and downwind in a sea where relative velocities are as indicated. But it should also be remembered that while velocity of the crest is indicated as 23 mph., this is the velocity of the wave motion and the actual particles of water are substantially zero velocity, except for whatever tide or current may be present.

In the upwind condition, while the hull is actually contacting the water at a speed of 55 mph, it is encountering the impact of the wave crest at 78 mph., and because of the actual low speed in the water, the dynamic lift of the hull is low, so that the hull tends to plunge through the crest rather than ride over it. On the other hand, in the downwind condition the airplane is overtaking the crests and because of its actual speed of 105 mph. over the water particles, the dynamic lift of the hull is high and the hull will tend to ride over the crests rather than plunge through. This dynamic effect on the hull is very powerful since the planing lift, just as wing lift, varies with the square of the velocity. In addition to the added dynamic lift, it is slightly more favorable to overtake a wave than to encounter it, since contrary to the theoretical conception of trochoidal wave form, the leeward side of a wave crest is slightly steeper than the windward.

Factors effecting a specific decision are, for the most part, based on the strictly local conditions at the time. If a strong wind is rising, the waves will lag the wind by a substantial

[1] Cornish, Dr. Vaughan, *Waves of the Sea and Other Waves*, p. 111, The Open Court Pub. Co., Chicago, 1910.

Table I—Average Relations for Open Water Waves

Wind	Beaufort's Number	Average Wind Velocity, Vw or Wave Velocity, V (mph.)	Length, λ (ft.)	Amplitude, A (ft.)	$\frac{\lambda}{A}$	Period, T (sec.)
Calm	0	2	1.7	0.98	1.7	0.6
Light air	1	4	6.7	1.95	3.4	1.1
Light breeze	2	7	20.6	3.4	6.0	2.0
Gentle breeze	3	10	42	4.9	8.6	2.9
Moderate breeze	4	14	82	6.8	12.0	4.0
Fresh breeze	5	19	152	9.3	16.5	5.5
Strong breeze	6	25	262	12.2	21.4	7.2
Moderate gale	7	31	403	15.1	26.7	8.9
Fresh gale	8	37	576	18.0	32.0	10.6
Strong gale	9	44	813	21.4	38.0	12.6
Whole gale	10	53	1,180	25.8	41.7	15.2
Storm	11	64	1,723	31.2	55.3	18.3
Hurricane	12	77	2,490	37.5	66.5	22.0

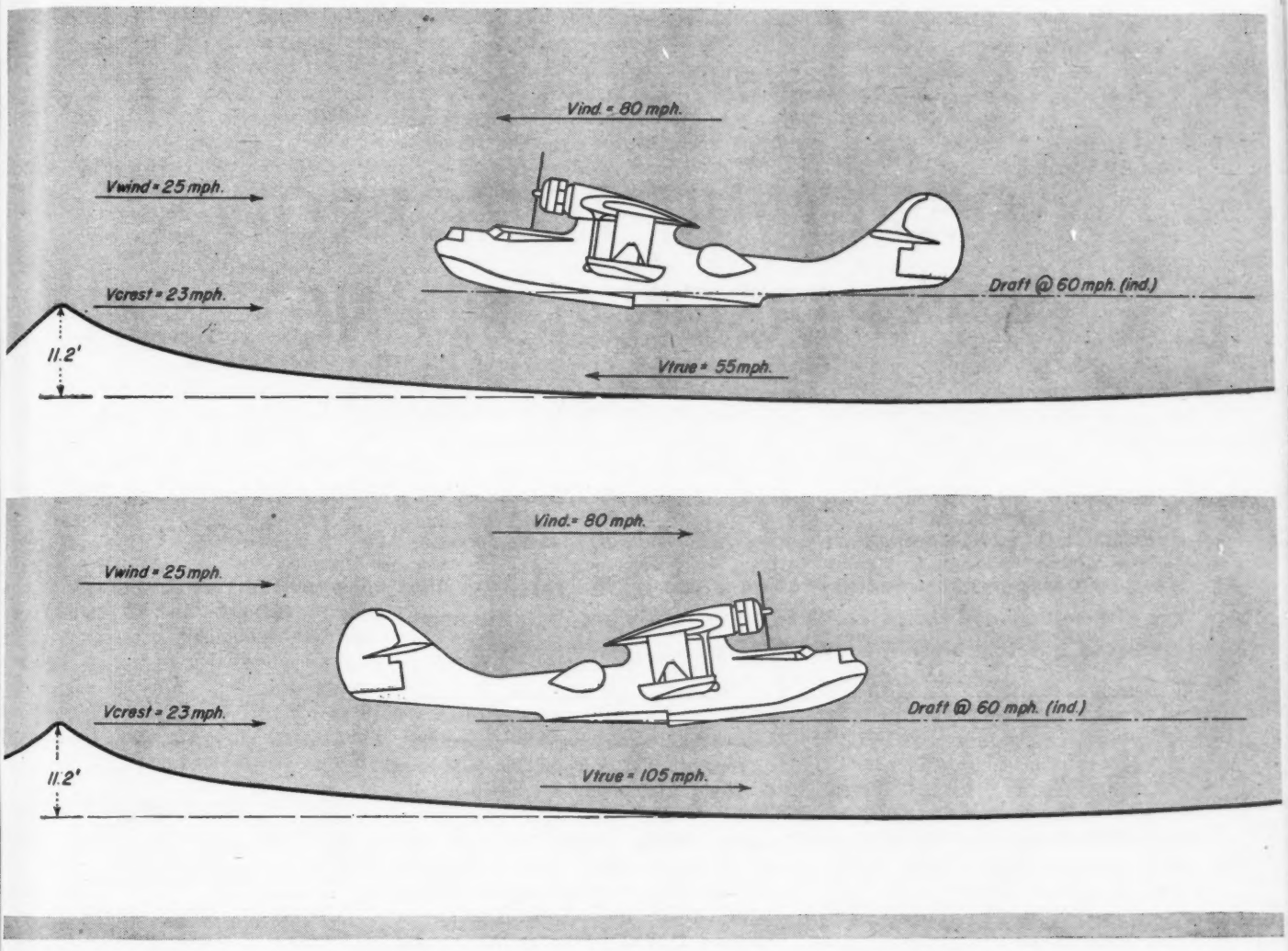


Fig. 3. Relation between upwind and downwind rough water landings.

margin, and it may be advisable to take advantage of the wind to reduce relative speed. Cornish, in his *Waves of the Sea,* states a typical case where on the first day of a 46-mph. wind the wave velocity reached 30 mph., or a relative speed of 16 mph. At the end of four days of steady wind the wave velocity was 43 mph.

Extensive ditching tests on various landplanes have shown in most cases that the minimum speed obtainable is the least hazardous. Here, however, the first impact usually causes extreme structural failure, so that the damage is usually caused by deceleration and the velocity of the water through the ruptured structure rather than the pounding of encountered waves. Here too, the dynamic planing effects are usually detrimental because of curvature of the fuselage and absence of a step, resulting in increased suction forces on the bottom with increased velocity.

Very frequently, as a result of shifting wind or other outside disturbance, the line of wave crests is not at right angles to the wind, and if sufficient time is available to determine this fact by dropping a smoke bomb prior to landing, a definite advantage is gained by landing parallel to the crests, in the trough of the wave. Usually, in any sea condition stronger than a Beaufort 6, this has been found to be the best practice regardless of wind direction.

As the sea increases in severity from Beaufort 6 on up the scale, the length of the wave increases rapidly, providing troughs of sufficient width so that a landing can be accomplished within the crests. Some pilots strongly favor landing parallel to the crests under all conditions, but as can be noted in Table I, the risk of hooking a wing tip or float in the crest is high in event of a narrow trough. Here again, the decision must be influenced largely by local conditions at the time. If the pilot is acquainted with these various possibilities and the fundamental theory governing the action of the sea beneath him, he will probably be in a better position to make a sound estimate of the situation and reduce the hazards involved.

Fundamental consideration in a landing at sea is, of course, to get down safely and remain afloat. Any method that will accomplish this purpose is satisfactory. Taking off again, however, requires a different approach. Here the object is to become airborne as quickly as possible, and in practically every case full advantage should be taken of the velocity of the wind. In most cases a downwind takeoff is out of the question because of the high water speeds required and the rapid increase in water resistance at these speeds. The trough takeoff, parallel to the crests, is a compromise in this respect but in all but the heaviest of seas probably is not as satisfactory as a direct heading into the wind, at least during the latter portion of the run.

DESIGNING TOMORROW'S PERSONAL PLANE

PART V

By RALPH UPSON, *Consulting Engineer*

Here is a step-by-step, fact-by-fact analysis of the sacrifices that must be made—and the research to be done—in creating the much-discussed but still elusive roadable airplane.

HERE'S A SUBJECT to start a hot argument in any hangar, shop or drafting room. Fervently boosted on the one hand, damned on the other, it seems to demand more than mere rational thought, as if it were some kind of a cult or "-ism". Some would have us believe that an airplane designed to "double" by traveling the highways is what the world has been eagerly awaiting, others that it will be a flash in the pan, a flop, a dud. There are even a few who seem to hold a middle position, and who should be prepared to take it on the chin from both sides. But seriously, isn't there some way to be rational and factual about this strangely explosive subject?

The first difficulty we run into in dealing with roadables is that currently there apparently *are* none. We may merely recollect such craft as the old Waterman tailless, that used to shed its wing entirely and run around the field for the entertainment of air-race crowds, also an autogiro with folding blades which came to its end by an unfortunate accident before it got fairly started.

If someone would only build an up-to-date roadable airplane that we could look over (including the price tag), fly and drive, it would be so much easier to say what's good about it and what's bad. On the other hand, if we just stop to think, it will be apparent that for a long time we have been actually part way to a roadable.

The original Wright airplane was designed exclusively for its own element, the air; and for a long subsequent period, ground control was greatly handicapped by lack of brakes and positive steering means. Now, however, the normal airplane can at least do a good job of getting around the airport under its own power. The next question is simply whether it is worthwhile adding further to the airplane's freedom of movement by providing it with means to travel the highways. Tentatively we shall assume the goal to be a vehicle which will remain intact, retaining all parts required for either air or road use. Lacking an existing example, there are apparently three possible methods of creating such a design:

1. Modify an existing design of automobile to permit its flying.
2. Modify an existing design of airplane to make it roadable.
3. By exploratory research or a stroke of inspiration, find an entirely fresh approach to the problem.

The Flying Automobile

For a preliminary attack by the first method, the following tabulation starts with a weight approximating that of the lightest automobile obtainable (as of Pearl Harbor). The automobile selected is a small light car with a weight only about a third that of the standard "light car". The methods explained in Part II of this series[1] are used to estimate the added weights required to obtain performance in the air similar to that of the airplanes already analyzed (575 lb. useful load less fuel; 120 mph. cruising; 500-mi. range; 10 lb./sq. ft. wing loading; 1[illegible] lb./hp. power loading).

Automobile (empty, without engine)	850 lb.
Wing (330 sq. ft.)	500 lb.
Wing folding mechanism	110 lb.
Tail and tail surfaces	175 lb.
Flight instruments and controls	40 lb.
Body and landing gear reinforcement and streamlining	90 lb.
Power plant, inc. propeller (194 hp.)	570 lb.
Fuel and tankage (56 gal.)	390 lb.
Passengers (3), baggage, and extras	575 lb.
Gross weight	3,300 lb.
Weight empty	2,390 lb.

Thus the weight is nearly double that of the lightest plane of similar performance, Type C, listed in Part II of this series.

Perhaps by starting with the airplane and working the other way we can do better. But this involves a rather fundamental principle that may as well be established first:

Primary and Secondary Weight

Weight carried for any specific purpose, other than the fulfillment of general strength and performance requirements, may be termed a primary weight. Examples include "beefing up" some specific part, more complete instrumentation, heavier trim or sound proofing, an extra passenger or more baggage. If the same major items of strength and performance are to be retained, however, any addition to such primary weight must be accompanied by appropriate secondary increase represented by increased wing area

[1] AVIATION, July, 1945.

engine power, fuel, and the structure required to carry the larger total.

In the final weight formulas, as developed in Part II, the total primary weight W_p is represented by the summation of numerical terms, including not only what are designated "basic or fixed weight" but also the constant terms from other items of weight. By contrast, all secondary weight W_s appears as a variable, dependent in the last analysis on the gross weight W. The rate of increase of the total weight relative to the primary weight is, of course, given mathematically by the derivative dW/dW_p. By reference to the same article, it will be noted that, for the assumptions there made, each item of secondary weight can be approximated as a linear function of the gross weight W. Hence the total increase in gross weight per pound of added primary weight is simply.

$$dW/dW_p = W/W_p = W/(W - W_s)$$

Expressed as a percentage for the different types of design already considered, each *100 lb.* of added primary weight involves the following actual total additions:

Type A	190 lb.
Type B	183 lb.
Type C	179 lb.
Type D	166 lb.
Type E	178 lb.

As can be seen, the figure varies somewhat with design, but not a great deal. Thus the effect of an added piece of equipment not involving appreciable direct drag can be approximated by adding up to 90% more to the gross weight. A small amount of this total represents added fuel weight to maintain constant range.

It may perhaps be objected that a moderate direct increase, such as 100 lb., need not necessarily involve any further addition. "The safety margins may still be high enough to satisfy the CAA; the takeoff and landing can probably stand a little increase in speed and distance; perhaps we don't have to be quite so concerned about the range; and anyhow, there is probably no actual engine available of just a few horsepower more," it might be argued.

"But these are all weasel words, showing an unwillingness to face the real issue—the straightforward appraisal of a proposed change. It is not that there is anything wrong about a performance compromise; it is simply that for a valid weight comparison we must stick to some common basis for it. For example, if we are really satisfied with a higher landing speed, there is nothing to prevent stepping up the wing loading; but it should be done in common for any designs being compared (if the comparison is in respect to some other feature).

The Roadable Airplane

Coming back to the problem of equipping an airplane for driving on the highways, design Type C, the cantilever low-wing with fixed conventional landing gear, appears most suitable if the forward vision can be made satisfactory. To retract wheels which must transmit power on the road seems unduly complicated, and a tail wheel seems practically necessary to support the weight of backward folding wings. Thus the major added weight will be that of the primary parts for road use, plus 79% of this total to cover the secondary airplane increase. It will be hard at the same time to avoid a little direct increase in drag due to a larger tail wheel, heavier tires and brake bands, and incidentals connected with the folding wings and driving gear. As a modest estimate for these effects, the drag area f is assumed increased by a primary increment of 0.50 sq. ft. with only a slight reduction in propulsive efficiency.

Judging from the example already given of the flying automobile, the engine power and torque appear adequate to take care of all conceivable road demands without the need of any gear ratio less than high. Thus a hydraulic transmission unit with reversing gear and a simple mechanical engagement to the engine, can undoubtedly be made to take the place of both clutch and gear shift. Furthermore, if split into two parts and put on the wheel axles, the hydraulic transmission could be used to replace the differential as well. Then if the engine is always stopped before shifting from wheel drive to propeller, or vice versa, a similar direct engagement can be used between the engine and propeller. The primary weight estimates of these and other elements are necessarily quite rough, but they are believed to be possible, although perhaps on the optimistic side.

Table I—Characteristics of Type C Aircraft*

	Non-Roadable	Roadable
Gross wt. W (lb.)	2,075	3,000
Fuel and oil W_f (lb.)	232	322
Weight empty (lb.)	1,268	2,103
Useful/gross (%)	38.9	29.9
Rated power (hp.)	122	177
Cruising $hp._{cr}$ (at 120 mph.)	86.0	119.3
Drag area f (sq. ft.)	5.48	7.35
Wing area S (sq. ft.)	207.5	300.0
Wing wt. (lb.)	302	456
Wing span (ft.)	35.3	42.4
Maximum speed (mph.)	130.5	133.2
Maximum climb (fpm.)	540	540

* Refer to accompanying "Score Card" reprinted from Part II of this series, July AVIATION.

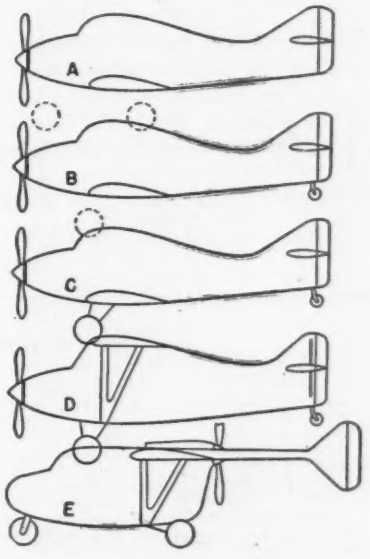
The Score Card—3-Place Airplanes

Design Type	A	B	C	D	E
Gross weight W (lb.)	2,200	2,115	2,075	2,185	2,450
*Fuel and oil W_f (lb.)	213	208	232	282	339
Weight empty (lb.)	1,412	1,332	1,268	1,328	1,536
Useful/gross (%)	35.8	37.0	38.9	39.2	37.3
Rated power (hp.)	129.5	124.5	122.0	137.5	165.5
Cruising $hp._{cf}$ (120 mph.)	79.0	77.0	86.0	104.5	125.5
Cruising/rated (%)	61	62	70	76	76
Drag area f (sq. ft.)	4.90	4.81	5.48	6.79	8.04
Wing area S (sq. ft.)	220.0	211.5	207.5	218.5	255.0
**Wing weight (lb.)	320	308	302	298	352
Wing span (ft.)	36.3	35.6	35.3	36.3	39.0
Max speed (mph.)	139.3	138.4	130.5	126.0	125.8
Max. climb (fpm.)	570	565	540	580	615

A—Cantilever, low-wing tractor; retractable tricycle gear.
B—Cantilever, low-wing tractor; retractable conventional gear.
C—Cantilever, low-wing tractor; fixed conventional landing gear.
D—Braced, high-wing tractor, fixed conventional landing gear.
E—Braced high-wing pusher; fixed tricycle landing gear.

All for aspect ratio $A = 6$; cruising $V_{cf} = 120$ mph. at 7,000 ft.; rated hp. $= W/17$, or more if required for cruising; $W/S = 10$; $W_f = 2.7$ hp. $_{cr}$. Useful load less fuel = 575 lb.

* Disposable portion (excl. tanks).
** Wing and bracing alone, without tail increment.



Characteristics of design Type C before and after making it roadable are shown here in Table I.

Both planes are 3-place low-wing cantilever with fixed conventional landing gear, and each carries 575 lb. useful load less fuel, with ultimate range put at 600 mi. (service range about 500 mi.) at 120 mph. and 7,000 ft., while wing loading is 10 lb./sq. ft., power loading is 17 lb./hp.; aspect ratio is 6, and there are high-lift low-drag flaps.

Primary weight and drag increase for the roadable: 470 lb. and 0.5 sq. ft., respectively, including wing folding gear, hydraudic transmissions, shafting, gearing, bearings and connections, extra-weight wheels, tires, brakes, and fenders, engine flywheel and cooling fan, and accessories required by road regulations.

Thus the roadable airplane seems to offer a substantial saving in weight compared to the flying automobile. The difference between the final figures arrived at by the two methods represents mainly a composite of (1) accessories in the roadable airplane better suited to the engine power and other conditions of use; (2) lower level of engineering refinement in a present automobile, compared to airplane practice; (3) extra material, which long experience with automobiles has shown to be desirable for maximum resistance to the continuous wear and tear of road operation; (4) a differential in favor of production economy on the part of the automobile.

That there may not be a corresponding saving in cost however is shown by the comparison in Table II. Here the relative selling costs are based on $0.50 per lb. for parts taken from automobile production, $1.50 per lb. for airframe parts, and $3.00 for airplane mechanical parts. This is an oversimplified basis, of course, and purely conjectural as to what the postwar unit costs in reasonable production may be, but it shows the principle involved. Similar data are added covering the purchased cost of an airplane *and* an automobile, both assumed new.

On the face of the returns it appears that the roadable airplane, although the lightest of the three combinations listed, is also the most costly. Of particular interest is the fact that it costs substantially more than an equivalent airplane plus a car—in fact more than the airplane plus two cars (one to leave at the airport, the other for the rest of the family).

The basis for such conclusions is admittedly open to question. The estimate of added parts is intentionally given as a total rather than itemized, because frankly the final total is the only thing that counts, and in a case like this it is almost certain to be more than any summation of individual items that can be made in advance. However, anyone who thinks he can do better is free to enter his own "guestimate"). As already indicated for the unit costs —although these appear to be reasonable possibilities for the near future— the writer makes no claims to proficiency at economic crystal gazing.

Other Possible Solutions

When we leave the realm of known facts to inquire into the possibility of an entirely new approach, the problem gets still further removed from the kind that can be handled by engineering analysis. Yet in what has already been set down, certain seemingly worthwhile simplifications have been assumed; also there are many other possible combinations of known elements, some of which will now be briefly examined.

One of the most interesting of these possibilities is the idea[2] of merely folding the wings and using the air propeller for short trips on the roads (such as a few miles from home to airport). In the only form which off-hand appears at all practical, this would mean a pusher whose wings could be folded back to give protection to (and from) the propeller. A tentative weight of such a unit can be quite readily premised on the pusher analysis presented in Parts II and IV of this series,[3] by applying the principle of secondary weight as here defined (treating the extra fuel as if it were weight empty, but neglecting any primary increase of drag).

A quick estimate on this basis gives for the *primary added weight:*

Wing folding mechanism..	77 lb.
Extra reinforcement (principally in tail and tail wheels)	40 lb.
Mud guards and misc.....	30 lb.
Total primary addition....	147 lb.
And for the *secondary weight:*	
78% of above total.....	115 lb.
(Increased primary drag neglected)	
Original wt. empty (Type E pusher)	1,536 lb.
Wt. empty for roadable..	1,798 lb.

comprising approximately 956 lb. of airframe and 842 lb. of mechanical parts for a total user-cost of $3,960.

As the latter figure shows no appreciable saving on the cost of the more complete roadable in Table II, we may as well skip a discussion of possible prohibitive legislation and other mere details.

Next for consideration is the school of thought that favors removing the wing and leaving it behind. From a strictly engineering viewpoint, this idea looks good; and it is too bad that as much cannot be said from the viewpoint of the private pilot. Perhaps even more than the engine, the wing is the heart of the airplane; and although plenty strong for its regular job, a lightplane wing is none too rugged for "kicking around" loose on the ground. It is commonly considered nowadays that a wing loaded much less than 10 lb./ft.^{2} presents an undue ground hazard from winds; but the same wing removed from the airplane has a loading on the order of 1.5 lb./ft.^{2}

A maximum lift of this magnitude would be developed at an airspeed of about 20 mph. Hence even in a moderate wind, considerable help would be required (or else hangar space utilized) for the removal and replacement operations. Even without the wind, and allowing for some ingenuity in the handling tackle, the safe maneuvering of a wing weighing several hundred pounds appears considerably more than a one-man job. Then safe, accessible parking space still must be provided for the wing—one can hardly imagine it staked out on the ground, even though it is left free to the elements when it remains in its proper place on a parked airplane.

The obvious purpose of all this complication would be to relieve the road-

[2] "Road-Running Airplanes," by H. G. Graybill, *Air Facts*, Aug., 1945.
[3] AVIATION, July and Sept., 1945.

Table II—Hypothetical Selling Cost

	Automobile & Airplane	Flying Automobile	Roadable Airplane
Automobile parts (lb.)	1,000	850	360
Cost @ .50/lb.	500	425	180
Airframe parts (lb.)	754	770	962
Cost @ 1.50/lb.)	1,131	1,155	1,443
Aircraft mechanical parts* (lb.)	514	770	780
Cost @ 3.00/lb.	1,542	2,310	2,340
Total weight empty (lb.)	2,268	2,390	2,102
Total cost to user ($)	3,173	3,890	3,963

* Power plant, landing gear, and wing-folding mechanism.

able, when on the road, of the heavy, cumbersome, vulnerable wing. But why stop with the wing? Particularly when taking off, why not leave behind the heavy equipment required for road duty only and which sets up such a big secondary penalty in the air? The objection is, of course, a still further complication—the fact that without the road equipment the vehicle would be unable to take to the road on landing at another airport. But the proposition is as broad as it is long; for, without the wing, the "plane" cannot take off at the end of a road jaunt, except at the particular airport where the wing is stowed.

To be sure, some of the roadable proponents have an answer to the latter objection: Develop a comprehensive wing rental or exchange system whereby all such wings would be put into a common pool to be drawn upon at any airport by any pilot who happened to need one. The same might apply to detachable tails, undercarriages, and other units. But isn't this getting a bit fantastic? How much more satisfactory to rent a complete airplane.

What About Changing Conditions?

In comparison thus far, we have insisted on the maintenance of all major performance objectives. There is another school of thought which holds that roadability in itself justifies a considerable sacrifice of performance in the air. But what performance? It would hardly be in respect to landing, for how could roadability affect either the basic problem of landing under the assumed limiting conditions, or the conditions themselves? If bad weather were closing in or the fuel gave out, are we to suppose that the pilot would find a bigger field if he had a roadable?

There is at least some sense to the possibility of allowing more takeoff distance, less climb, and less speed by keeping a relatively low-power engine in a roadable. Here it might be argued that, if you are on the road, you might as well keep on it till you get to a really ample field. Then, providing you can still meet the minimum climb requirement, and it doesn't take too long to spread the wings and secure all connections, perhaps a little could be allowed off the cruising speed because you didn't have to wait for your wife to finish the dishes and run you out to the airport, and because there may not be a taxi immediately available at the other end. And if you get held up by bad weather you can drive on in the same contraption and don't have to wait for some other conveyance.

The basic fact of using the airplane on the road and not having to leave it at the airport *may* be worth a monetary consideration, but it is hardly a basis for a scaling down of performance. On the other hand, this privilege seems small consolation for being saddled with a costly vehicle that has no "get-up-and-go", either on the road or in the air.

A more basic change might in time be effected in the unit weights or cost; but by its very nature, the mere possibility of such future change is hardly a subject for rational engineering discussion, except in respect to the justification and plans for definite research in such directions. Here it should be noted that, in most respects, general design improvements, such as lighter and cheaper components, will not in themselves put the roadable across; because every improvement of the combination vehicle by such means will only keep it trailing the still further improved airplane and automobile as separate units.

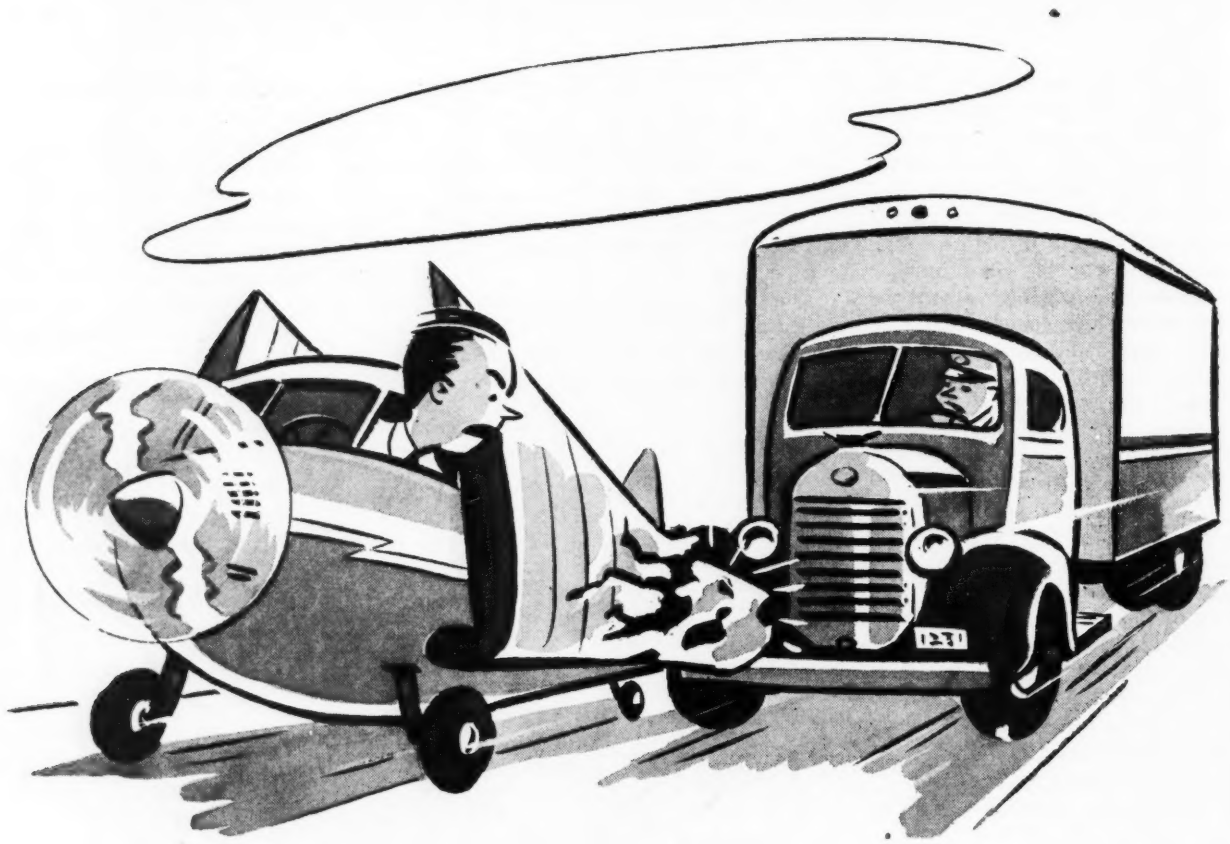
The roadable's only real salvation for widespread personal use appears to depend on some development that greatly improves the combination vehicle *without corresponding improvement in the air or road vehicles separately*. One interesting possibility along this line, recently proposed, is the controllable wing.

The basic principle behind the controllable wing is simple and entirely sound: Instead of deflecting small supplementary surfaces to obtain control, the entire wing is deflected about a central pivot, with essentially the same results. Secondary differences, both favorable and unfavorable, appear to include the following:

Advantages: 1. The wing can readily be turned to line up with the fuselage for storage and road use.

2. There is direct control of lift by angular deflection of the wing alone, rather than by that of the entire airplane.

3. With the pivot far enough forward, and a yielding restraint against upward movement of the trailing edge, it appears possible for such a wing to spill a considerable proportion of gust force to which the structure and



occupants would otherwise be subjected.

Disadvantages: 1. Substantial control force would be required, particularly to handle lateral inertia, and to supply the variations in longitudinal control force involved in Item 3 above.

2. Unless some practical means of using flaps can be worked out, the controllable wing will be under nearly as great a handicap, with respect to required wing area, as the tailless type.[4]

3. The special type of wing mounting, with control connections and clearance for required movement, apparently involves a considerable increase in drag over that of the built-in type of wing.

Moreover, referring back to Item 1 under advantages, the substantial length of the one-piece wing (to be turned to line up with the fuselage for storage or road use) would appear to require supplementary bracing; turning on the road would be a problem similar to that of a hook-and-ladder truck; and there would be no possibility of housing in an ordinary garage. Also, regarding Item 2 under advantages, substantially equivalent lift control could be had by the use of low-drag flaps.

In any event, for actual roadability, the craft would of course still carry in the air the weight handicap imposed by all equipment required for road use, aggregating considerably more in any case than what is involved in folding the wing.

Folding Wings

We come now, more specifically, to consideration of the pros and cons of merely folding the wing, without trying to do everything else imaginable. It is obvious that by folding the wing—or aligning it with the fuselage—a plane would take up less hangar space and require a smaller individual hangar. In certain forced landings, it could be more readily extricated from surrounding obstructions, although it is hard to think of specific cases where such a feature would have been highly important. If not maneuverable under its own power on the road, the plane with folded wing could at least be towed by a car, assuming of course good brakes, positive steering gear, better-than-average vision, and adequate support for the wing.

Accepted as a standard feature of our shipboard fighters, doesn't a folding wing appear off-hand to be a reasonable desire for a private pilot? Somewhat in this way we put the question to one of our leading manufacturers who produced a wellknown and successful folding-wing airplane many years ago, going on to ask him why he quit.

He said, "For two good reasons: The weight, complication, and cost weren't justified by the few times the folding feature was ever used; and this weight would be increased in a modern cantilever wing.[5] Also I got tired answering the same old question, 'What if the wing folded in the air?'"

History seems to show that the trend is usually away from combinations that appear complicated in their requirements for special handling. A combined topcoat and raincoat of conventional materials won't sell purely as a raincoat because it is too warm if not also too costly; and it won't sell as a topcoat unless it is primarily a good buy for that purpose. The "one-man top" and power-operated tops failed to do more than save the convertible car for a high priced precarious existence. Even such a logical and relatively simple combination as the amphibian plane has hitherto eluded all attempts to popularize it. One entirely successful combination, the radiophonograph, is quite unusual as involving no apparent disadvantage for either component, and requiring no more than a switch to change from one to the other.

It has been shown that by no known method can serious disadvantage be avoided, both economic and mechanical, in combining airplane and automobile in one vehicle. Halfway measures, such as detaching the wing and tail

[4] Discussed in Part IV, AVIATION, Sept., 1945.

[5] The lowest estimate by this writer increases the wing weight 22 per cent (excl. secondary increases).

offer other disadvantages, and even a folding wing alone not only adds a substantial weight penalty[6] but poses a serious question, based on past experience, as to how much it would be used. As already indicated, not only the direct or primary weight of special equipment must be taken into account but also the indirect or secondary increase of existing parts. The addition of a folding feature to a wing originally weighing 302 lb. (Type C design) would involve a total minimum addition approximating: 1.79 x .22 x 302 = 119 lb., with corresponding increase in initial cost. The operating cost would also be increased unless balanced by the savings in hangar rental, etc. Neglecting any direct drag increase and differences in flying cost, the above weight increment, at the assumed unit cost, would mean $357 increased price to the user. Although no attempt to say what the hangar saving might be, it is clear that $10 per month would write off the total—without interest—in about 3 years.

Thus, in most cases, the question is mainly one for quantitative analysis, so often lacking in discussions of this kind. The proposed use for a wingfolding or roadable feature must be sufficiently important to justify the complication and cost (as for various military uses). For average personal use, it will be hard to overcome the sales deterrent of several hundred dollars more for a folding wing, not to mention the much higher cost of a true roadable plane, even if the net operating cost appeared less. Still it seems that there should always be some market for a good folding-wing design.

How Far Can We Compromise

Even at best, various unfavorable compromises would apparently be required for road use, including large over-all dimensions but less than otherwise desirable wheel tread, interference of wing and tail with access and with maneuvering, means for getting the large expanse of wing and tail area into a relatively protected position, safeguards to prevent starting the propeller on the road, and omission of desirable equipment such as spare wheel, bumpers, and tools.

[6] Not applying to helicopter blades, which are obviously in a different class, but have problems of their own (see Part I, June AVIATION).

In the matter of convenience, it would seem that every argument for combining the automobile and airplane can be matched by one for keeping them separate. For instance, let us imagine that the prevailing type of plane today was roadable. A manufacturer introducing a straight airplane could then properly claim that his product was not only much cheaper but, being already in flying condition, would save time and unpleasant effort for the change-over. Engine life and the time between overhauls would be increased by enabling use of a cheaper engine on the road.

Vital aircraft parts would be spared the constant risk of serious damage on the road in minor mishaps that with a regular car mean no more than a dented fender. Finally, a separate car has a real advantage, in that it can be left behind for other members of the family to use; and the transportation eggs aren't all in-one basket.

But how about the basic problems of high hangar rental, getting to and from the airport, and weather-occasioned uncertainties that the roadable was supposed to solve? Surely, these problems are still with us—no dispute about that; it is only the proposed solution that is in question. Although here, too, there are several available methods of attack, it is the writer's opinion that the most helpful steps toward the solution of these problems will be obtained from:

A—Planes which can be left out in the open.

B—Further simplification of control and of instrumentation extending the possibility of safe use in bad weather.

C—Widespread, coordinated fly-yourself and drive-yourself rental service; rapid transit connections in urban areas.

D—Roadside flight strips and servicing facilities.

E—The development of small communities and industrial centers, each immediately adjacent to a flight strip.

Although further discussion of these items is beyond the scope of this article, it can be said they all appear not only feasible but almost in the line of natural development, item (E) being dependent on progress otherwise.

We come back then to the primary object of airplane design: To get a good airplane, without unduly compromising it for road duty, farm tractor service, house lighting, water pumping, or many other uses to which an imagination might readily lend it.

Next month Mr. Upson will delve into the many problems connected with another much cussed, discussed, and often-misunderstood type—the amphibian.

DESIGN YOUR PRODUCT FOR EFFICIENT SERVICING

By DWIGHT A. WRIGLEY,

Analyzing reasons why economical servicing can best be obtained when design for service is at all times kept foremost in the mind of the manufacturer.

BECAUSE THE DESIGNING DRAFTSMAN is often ignorant of the precise subsequent utilization of the product he designs—through neglect on the part of management to acquaint him with servicing requirements—it is not infrequent that the finished article, though excellent from an engineering standpoint, is unsatisfactory in use because of difficulty in servicing.

If the customer is to remain satisfied, engineering design must take into account the problems of the maintenance force in the field just as much as it considers the key problems of production.

A Competitive Advantage

Through the development of our industrial standards and processes, we have seen products approach a stage of "equalization." Because every manufacturer of a given product in the same price class manufactures a "good" product, it is increasingly difficult for the prospective customer to choose between sources for his initial purchase. But there is another basis on which he can choose—service—initial-cost plus cost-per-year, or the actual over-all cost of the product.

In a competitive market, there is a tremendous opportunity for the manufacturer who will establish a design policy based on service, starting with a study of the conceived product while it is still in its formative state. To take advantage of such an opportunity is only to carry present practice one step further. For every manufacturer must establish some service or maintenance policy, and to design for service is merely to state the policy in definite terms before design takes place, so that the design may evolve around it.

Type of Servicing

The manufacturer must have a definite policy as to whether he intends to control servicing directly through his own agencies, remotely through authorized facilities, or whether he will have no post-sales interest other than in the supply of replacements. He must make a further decision as to whether he will market a product to be replaced entirely, or one which will consist of factory replaceable or commercially available parts. Since the evolution of the design around one of these policies will be fixed in terms of manufacturing and servicing costs, it is obvious that someone's pocketbook will suffer, if a change in policy must be made after the design is fixed and production started.

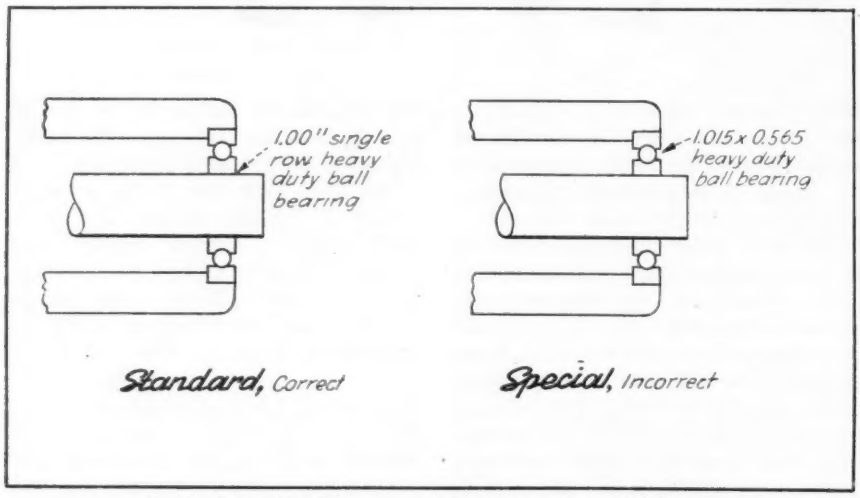
Evolution of the design obviously follows this maintenance policy and may take one of several courses. What repairs and replacements are anticipated? What facilities and tools will the servicing agency possess? What repair methods are anticipated? These considerations will determine the design for service.

If the product is for universal, rather than specialized, usage, it is desirable that it should consist of a basic unit which may be modified to form several combinations. Even the specialized product should, if possible, be special only in function and should be made of standard components. Parts which are expected to require repair or replacement should be so designed that these operations will be economical. Special tools, fixtures, gages, and processes should be reduced to an absolute minimum.

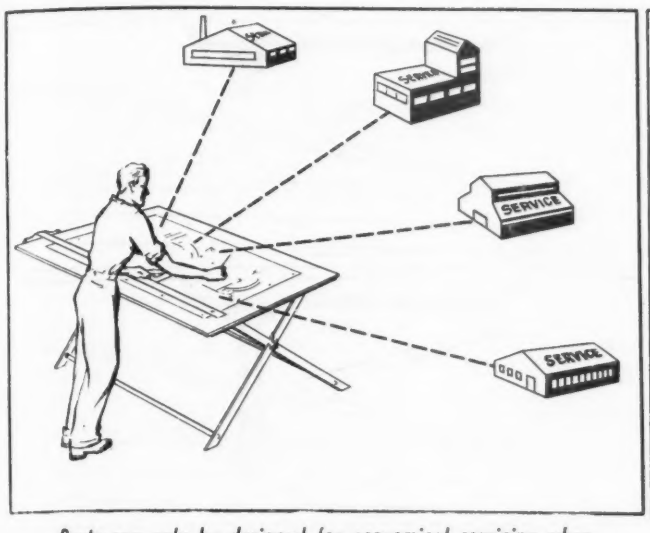
Usually, practices which are economical to the servicing branch will be equally so to the producer. Let the diameter of female fittings for which standard plug gages are available determine the diameter of the male fitting. It is easier and cheaper to use micrometers on a shaft than to order special tools to make an off-standard hole. It is more economical to specify fillets made by standard milling cutters than to send the cutters to the tool crib for a special modification.

Every designer should check the capacity of the straddle mills and profilers, and dimension accordingly, rather than request special set-ups and adapters. Service stations may not have the special fixtures and tools which would be required, all because of a lack of a few minutes of consideration by the designer. It is also advisable to know the tolerances obtainable with standard tools and to specify them, rather than to use tolerances which require an experienced, high-priced operator.

Design the part for the type of repair which is most feasible. Can a worn or elongated hole be bushed?



Standard sizes (left) have many advantages over special design (right), both in economy of manufacture and in replacements.



Parts can only be designed for economical servicing when tool capacity of the servicing agencies is considered.

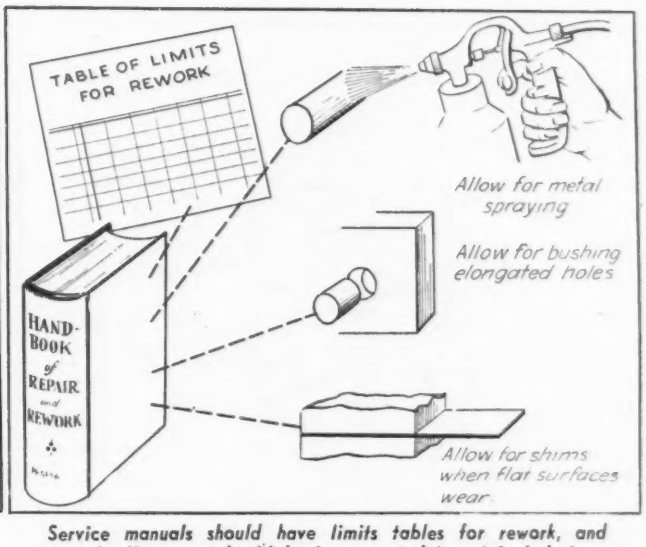


TABLE OF LIMITS FOR REWORK
HAND-BOOK of REPAIR and REWORK
Allow for metal spraying
Allow for bushing elongated holes
Allow for shims when flat surfaces wear

Service manuals should have limits tables for rework, and rework allowances should be incorporated in original designs.

It is much cheaper to bush a hole than to use an oversize mating part. Can the part be repaired by welding or brazing? Can it be reclaimed by plating or metal spraying? Why not design built-in allowances for repairs?

What Factors Must Be Considered?

Design engineering is the creation of the best possible product, unencumbered by restrictions. Unfortunately, the ideal is seldom possible, and practical limitations must be imposed upon the design. To avoid uneconomical tooling and the use of expensive materials, the designer has to adapt his ideas to present practices. Unfortunately, the most economically produced design is not always the best for servicing or maintenance. In order to provide the customer with an economical product, its design must again be modified to adapt itself to present conditions and technological practices. To conform with correct design for service, each part should whenever possible, be (a) interchangeable, (b) accessible, (c) serviceable, and (d) adaptable.

Interchangeability is easily defined. It's the ability to replace a part with another part from stock. In practice, several degrees of interchangeability can exist. Items may be interchangeable by assemblies but not by individual parts; assemblies drawn from stock may be interchangeable while the parts themselves are not interchangeable between units, or parts may be interchangeable but the assemblies not so. The ideal is that any part should be changeable with any other similar part.

Interchangeability is most often negated by the adherence to uselessly close tolerances. A study of drawing tolerances at random will show many cases where large tolerances, are justified, yet the conventional $\frac{1}{32}$ in. for sheet-metal and .010 for machined parts are blindly specified. Most rejected parts are interchangeable in all respects except for mounting hole locations, yet very few parts are so attached that the fit of the attaching bolts in the holes is critical. Here, then, is the first and largest item on which improvement can be made. Probably the second most important item is in the use of special tolerances, sizes, and lengths of mating parts.

Accessibility affects the economy with which parts may be serviced and replaced. There are three distinct factors involved—ease, speed, and cleanliness—and each should apply to every maintenance process, not just to a few of them. Ease and speed of inspection and adjustment are not enough, if replacement takes the better part of a day, plus time of the entire maintenance crew, and all the shop equipment available, while also necessitating an inordinate period to clean up the mess.

Serviceability is built-in preventive maintenance, protection against abrasion, corrosion, and vibration, plus adequate security of fastenings. It is often, a refinement which will obviate localized trouble later and will accordingly reduce maintenance.

Adaptability is the ease with which component parts lend themselves to handling and storage. Engine or aircraft parts may be well designed, well located, and accessible, yet be too large or cumbersome once they have been removed. If it requires more manpower or special hoisting and storage equipment to remove and store the parts—then they are not adaptable.

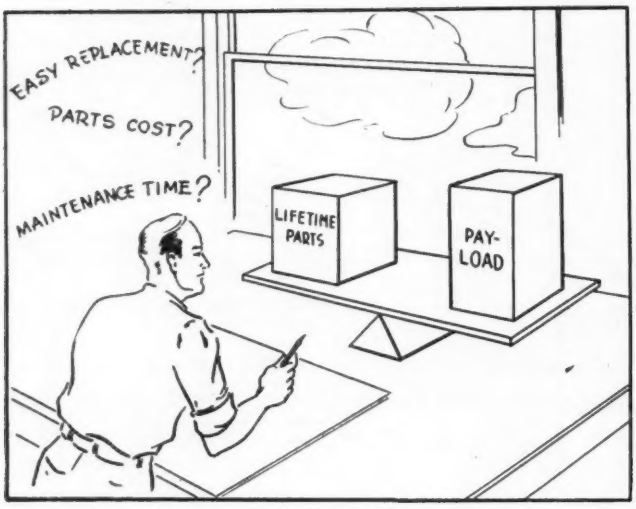
Service Equipment

Information from field service engineers will give a good idea of what facilities are available at the agencies which will handle the product. There are certainly instances where customers might well blame poor servicing or repair directly on the producer rather than on the service depot. Intelligent users are quick to spot the article which is not serviceable. If servicing is to be under your control, ascertain the extent of available facilities. If the call for special equipment is too great, the manufacturer may end up in the service field—which may be just the thing he wishes to avoid. If the product is planned for economical production to commercial standards, specified tolerances should be met.

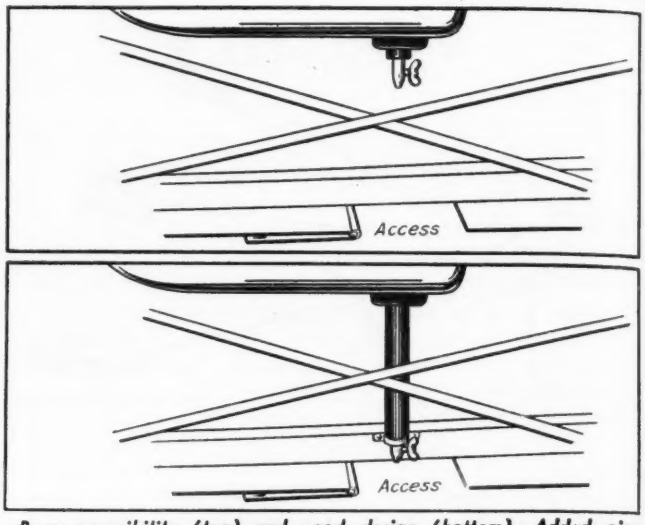
Factory shop equipment should be compared with that available at service centers. It is possible that special or precision factory tools are being used merely because they are available, although less close tolerances would be sufficient. Can these tolerances be relaxed so that the equipment at the service stations will suffice for the work? Their hourly production rate need not be as high as that of the manufacturer, so that the same tools need not be used, but the tolerances must be such that other, simpler tools may be substituted.

What Is a Satisfactory Repair?

How does a service station know when a repair is possible? Will the repair pass inspection of the customer? What has been done other than to provide lists of spare parts? Always that question of "repair or replace" arises. Often the practice has been to replace rather than repair. When rigidly followed this policy is uneconomical and hurts the reputation of a product. The average person hates to throw away anything; yet that is what he must do if he has to replace his worn or damaged parts. When possible, parts should be designed so that



Parts life and weight may safely be reduced, with consequent payload increase, if maintenance considerations govern design.



Poor accessibility (top) and good design (bottom). Added pipe eliminates chance of oil flowing over structural members.

they can be repaired or reclaimed, and service agencies should be informed regarding limits of wear or rework.

All mating parts have tolerances, but are these tolerances the maximum that can be permitted? Many parts can be reclaimed by plating or metal spraying. But are the parts designed at the critical limit, or is there a margin which can be used for grinding before plating or spraying? When holes are worn or elongated, they can be opened up to the next size and a special oversize part can be used. Could the hole preferably be bushed so that a standard part could still be employed? Can a shim be used to obtain proper alignment of flat surfaces, or is the worn part critical in bearing so it will not stand the reduction in thickness?

Tables of limits are recommended as the best means of furnishing information on allowable wear. Maximum and minimum limits for original assembly (or complete overhaul) are specified, and in addition so-called "field limits" are provided which give the maximum recommended for satisfactory operation. Parts with limits between original maximum and field maximum often will be entirely satisfactory for the life of the product if it is seldom operated at its designed rating. By establishing these extra working limits it is possible to keep the product operating satisfactorily at little or no cost to the user—a good means of promoting repeat business the next time such equipment is ordered.

Wherever critical strengths are involved, the designer should show allowed repairs, not just by area and type, but in detail. If customer or government inspection is required, preapproved repairs should be furnished so that calculations and individual inspection will be eliminated. So many structural forms are standard that compilation of repair instructions remain relatively simple in such cases.

One problem continually haunts both the aircraft designer and operator—that of weight translated into operating costs. Is it economical to add weight in order to insure against loss-of-use by making repair and replacement easy, while reducing the payload accordingly? Here many unpredictable factors are involved. Careful detail design will help to solve the problem by reducing possibility of failure.

Interchangeability in airplane parts is most commonly defeated by improper specification of close tolerances. In aircraft manufacture close tolerances are necessary, but they are difficult to attain due to the physical characteristics of light metals. Though these difficulties exist, it is believed that their importance is over-stressed, and a study of the following processes will clarify this statement.

First is the bugaboo of accumulated tolerances—caused by too many reference points. If we assume that the standard tolerance of ± .010 is satisfactory for jig-assembled parts, this figure should be the maximum tolerance on over-all, as well as on any of the intermediate, dimensions. This means that there can be but one reference plane for each axis on each major component. It is not enough that flap and aileron hinge locations be individually correct; they must also be correctly located with respect to the span, chord, and camber reference planes.

Assuming that all locating dimensions are correct and that accumulated tolerances are nil and are tied to a single reference plane, will the parts then be interchangeable? Theoretically, yes; but practically they will not necessarily be so. Unless the manufacturing and assembly jigs are dimensioned to the same reference planes and are held to tolerances in themselves smaller than those permitted on the completed product, interchangeability is not necessarily achieved. Of course, parts from the same jig will be interchangeable among themselves, but not with parts coming off other jigs or from subcontractors.

Because locating-dimension tolerances are ± .010, it is apparent that the same dimension of two similar jigs may be .020 apart—not a great variation, but enough to prevent interchangeability. If one jig locating-dimension tolerance is ± .008 and the corresponding dimension on a similar jig is —.008, there is a variation of .016. Now, if the corresponding dimension on a *mating* jig is ± .008, one set of mating parts may mate, while another set may not. Jig tolerances must be small enough to permit *jig* interchangeability, and this usually requires the use of unilateral, instead of bilateral, tolerances.

Interchangeability of parts is a manufacturing responsibility. Placing of tolerances on locating-dimensions by the draftsman means that the part will work as long as the dimension is between the tolerances shown. At its discretion, the manufacturing division can work anywhere within the tolerances and be sure that parts will fit.

Another form of improvement is in the use of greater tolerances in attaching parts. There is no valid reason for fairing, cowling, and inspection and access doors to be attached with screws or fasteners through "body drill"-size holes. Oversize and slotted holes providing universal movement would eliminate the alignment problem, especially on parts with double-curvature, and they would make a better fit.

Why Not Service Centers?

Inspection, service, and access doors add weight, causing the stress men to have nightmares. These features can really be detrimental to aerodynamic properties, hence it is in the interest of the designer to keep such openings to a minimum, when possible with no penalty to accessibility.

In this regard, why not have special service centers built into aircraft? Layover time at airports for servicing, inspections if necessary, loading and unloading of passengers, baggage and freight are expensive in terms of operating costs. To reduce the number of openings in the structure and to cut down layover time, such service points should be concentrated at a few spots which will not interfere with other operations. Fueling, oiling, and checking of hydraulic and de-icer fluids should be included in one group; passenger loading should be at another location; and baggage or freight handling at another.

Related servicing should be grouped; one inspection door in the outer panel should suffice for access to cable pulleys, turnbuckles, electrical disconnects, fuel, oil, hydraulic and instrument lines and fittings; another door could cover checking of the tail group, with a door for the tail cone area, including all units of the tail wheel—oleo inflation, lubrication, retracting mechanism, etc. The designer wants fewer "holes" while the maintenance man wants centralized work.

Do It the Easy Way

Serviceability is accomplished when each part can be kept working while it takes all loads imposed upon it. Often the designer blames the servicing crews for damage, when actually the trouble was "designed in". Access doors and cover plates are not originally intended to be walked on, or to be on the receiving end of a dropped fuel hose nozzle—yet the designer in many cases provides no alternative. A certain amount of servicing is necessary on every airplane, yet the actual procedure is seldom if ever tried out on the mockup.

When wing fuel tanks are serviced, a man must be on the wing, and the fueling truck has to get the hose up to him. Has a check been made on the mockup to see where the hose might land and what damage might result if it is dropped? Dents on the leading edge have caused severe tail buffeting. A reinforced cover plate instead of a sheet of thin, formed metal would have obviated this condition.

Gravel, dirt, and sand blown back onto the tail structure by the propeller result in a really efficient sand-blast. Sometimes the stabilizer leading edge skin is made of heavier gage to withstand such abrasion—usually it is not. And almost never is the leading edge quickly detachable. More frequently the attaching rivets are inaccessible and repair is expensive. Blasting the Alclad off the skin by propeller action is a very good way to start corrosion.

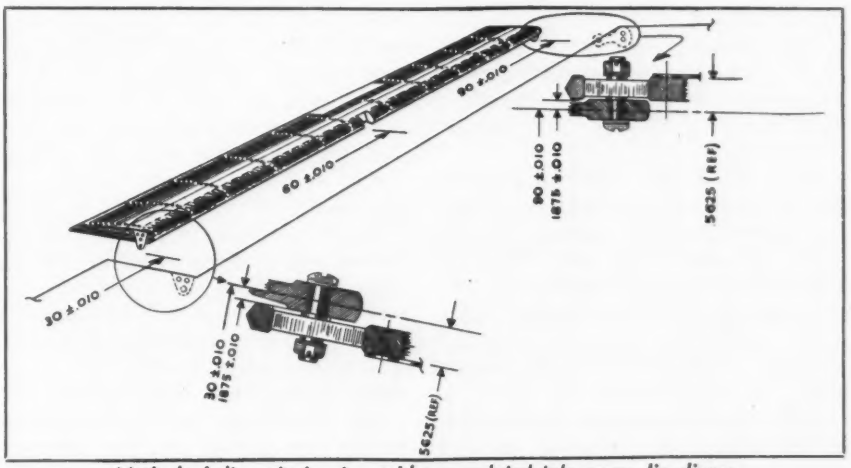
Must It Be "Manhandled"?

Watching a maintenance crew manhandle a section of engine cowling will demonstrate what is meant by poor adaptability. The particular section is interchangeable in all respects. Just loosen a few quick-action fasteners and it is ready to come off, giving ideal accessibility to the engine or accessory section. The answer to a maintenance man's prayer? Not at all, because here comes the relief crew with a tractor-crane and a special dolly to help get it off the airplane and move it around.

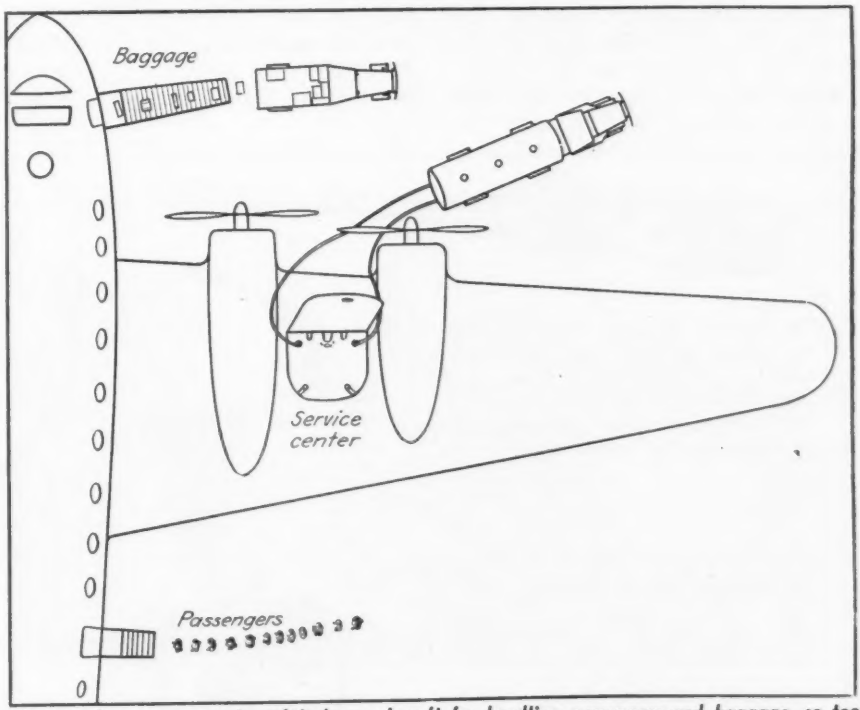
The best engine installation in the world is not easy to work around, and removing cowl panels with one man on top and more around on each side is definitely undesirable. After removal, the cowl panel has to be gently lowered to the ground and stored some place. Lay it on its side and it will get dented and scratched. Stand it up and the wind promply blows it over!

Need is for the design of parts so they may be handled and stored easily, and so that they won't fall off and get lost, or fall through access doors into the interior of the structure.

Initial cost is not the greatest consideration when purchasing new equipment, but yearly operating costs—what it actually costs to keep the equipment running—is of decided import. Lower maintenance costs mean lower operating costs; lower operating costs allow lower rates and higher profits.



Method of dimensioning to avoid accumulated tolerances. Jig dimensions must be close enough to assure interchangeability of parts.



Just as there are separate points in an aircraft for handling passengers and baggage, so too common "service centers" may be built in to handle mechanical work, thus saving much time.

Self-Contained Subassemblies Feature B-29 Four-Gun Turret

PART II

By **P. E. HUMPHREY**, *Aeronautic & Marine Engineering Division, General Electric Company.*

Concluding his revealing part-by-part study of GE's firepower-plus turret, Author Humphrey gives details of the gun charger, compressed air, collector, and fire interrupter units, then describes how the completed four-gun assembly is installed on the Boeing Superfort.

NEXT AMONG the four-gun turret's compact components—each specifically designed both for ease in manufacture and for convenience in field servicing—is the gun charger (Fig. 12).

This automatic electro-pneumatic unit is fitted to each gun for initial loading, operation of the trigger, clearing jams, and removing duds. It comprises three operating units: (1) Firing solenoid, (2) solenoid-operated air valve and power cylinder assembly, and (3) motor-driven timer or control unit.

When the firing trigger is closed, the firing solenoid is energized and the timing motor starts. If the gun fires, the timer is continually re-set and the charging unit remains inactive. But if the gun fails to fire after about ⅓ sec., the timing mechanism closes a switch energizing the air valve solenoid, and high-pressure air admitted to the charging cylinder operates the gun through one cycle. At the end of the stroke, the bolt stud re-sets the timer, and another charging operation will not take place until the trigger switch is held closed for another full time delay.

If the gun does not fire after five consecutive charges, a counter in the timing mechanism cuts off the charging circuit and prevents further operation until the hand reset button is pushed. This arrangement is necessary to prevent wasting the high-pressure air.

Air at 1,000-psi. pressure is supplied to the gun chargers by an automatic compressed air system (Fig. 13). The compressor and pressure cylinder with the automatic pressure switch are mounted on the lower part of the turret frame between the ammunition cases. Here, the compressor is a two-stage high-speed unit designed to operate at high altitudes and extreme temperature limits, and the pressure cylinder has a volume of about 39 cu. in. This provides sufficient air to operate all four gun chargers simultaneously through five charging cycles with a pressure drop from 1,000 psi. to 400 psi. However, under normal operation, the compressor is started as soon as the pressure drops below 1,000 psi., and it keeps the system fully charged.

All the control and power circuits are brought into the turret through one connector at the bottom of the collector or slip-ring assembly (Fig. 14). Wires from the connector go up to brushes which are mounted on a non-rotating bracket. This portion of the collector is held against rotation by an anti-rotation bar connected to the airplane.

Slip rings are mounted below the top plate of the collector under the terminal board and rotate with the turret. Wires run up through the center of the rings and are fastened to the terminal board. Connections from this board are made through conduit assemblies to the various units.

A fire interrupter unit (Fig. 15) is built around the collector assembly. The enclosing drum around the brush assembly serves as a stationary interrupter cam drum. As for the switch carriage, it is mounted on vertical

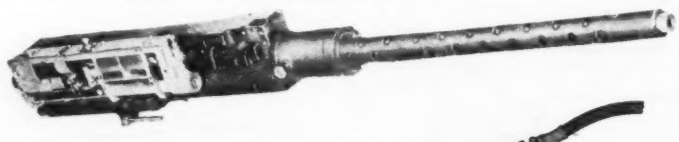


Fig. 12. This 50-cal. unit of GE's B-29 turret reveals automatic electro-pneumatic gun charger. Incorporated are three operating units: Firing solenoid, solenoid-operated air valve and power cylinder assembly, and motor-driven timer or control unit.

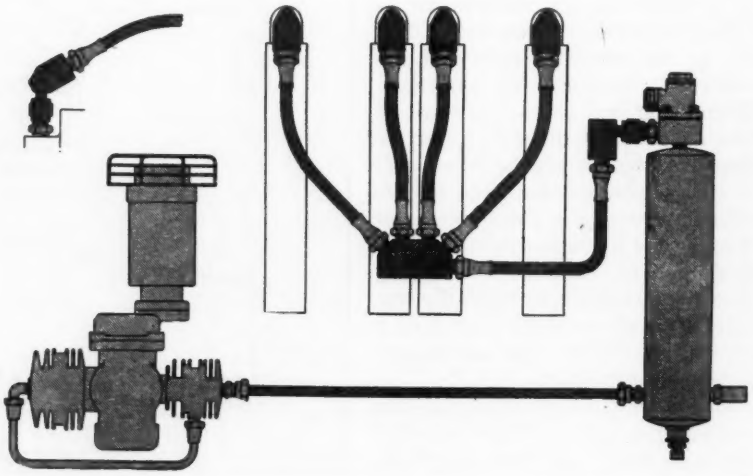
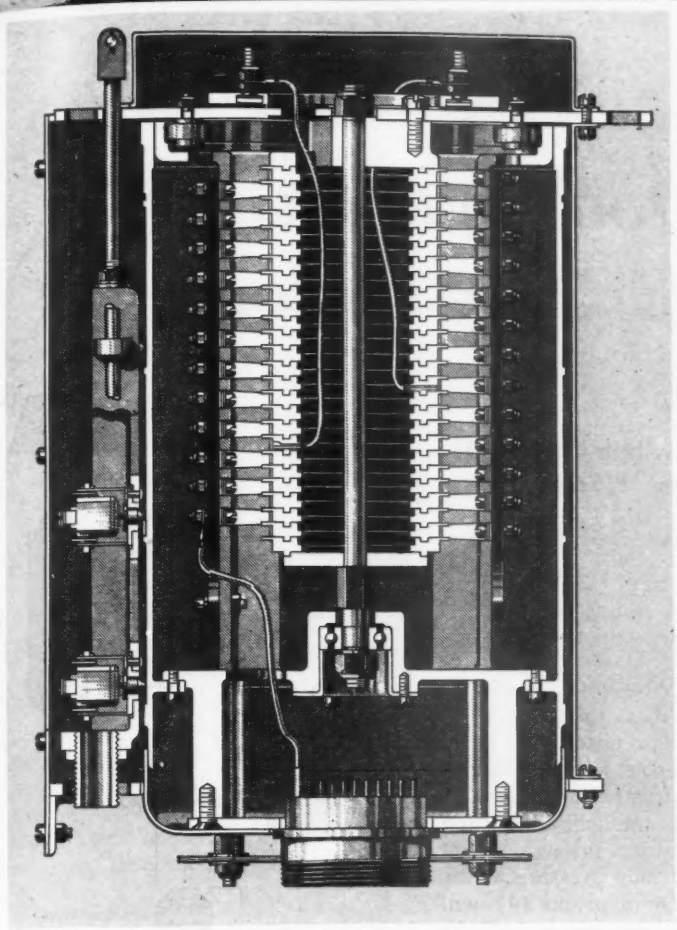


Fig. 13. Schematic drawing of compressed air system for four-gun turret.



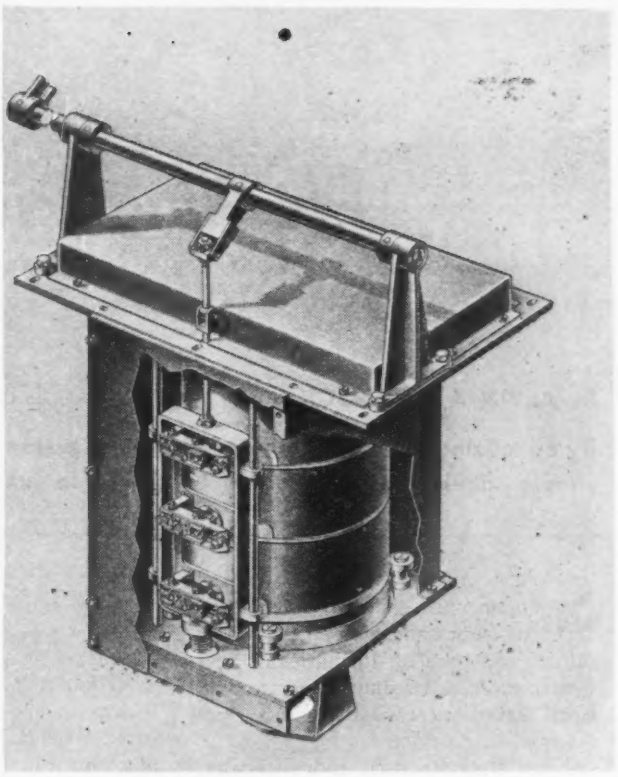


Fig. 14. (left) Cross section of collector assembly. Fig. 15. (right) Cut away drawing illustrates how fire interrupter unit is built around collector assembly.

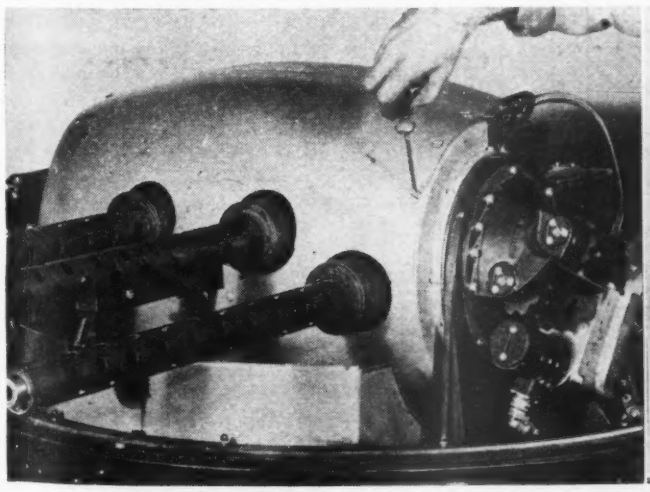
slide rods, and it travels around the drum with the turret and is moved up and down the drum by linkage connected to the elevation motion of the guns. Three switches are provided, one for each outside gun and one for the two middle guns. Thus, the most complete fire coverage is allowed each gun.

The interrupter switches are actuated by bevel-pointed plungers which ride up over the interrupter cams in areas where the gun is pointed at parts of the airplane. Since the cams are mounted on the stationary drum, their contour is simply a reproduction of the pattern traced by a bore-sight through the gun barrel following around the contour of the airplane. A margin of safety of 1½ deg. is allowed to take care of errors in the system and to cover time for the firing solenoid to drop out when the turret is moving at high speed.

The interrupter cam drum is an aluminum alloy casting machined inside and outside to a ⅛-in. wall thickness. Stainless steel 1/16 in. thick is machined to agree with a master drum (by an accurate profile milling process), after the cam surfaces are ground concentric with the drum mounting surfaces. The complete interrupter and collector assembly is enclosed in a fabricated sheet aluminum case.

At installation in the airplane, the complete turret is lowered into the turret well, with only the dome needing to be removed to allow the hoisting sling to be attached. For additional reference, Fig. 16 shows the upper half of the gun enclosure being removed from the turret, while Fig. 17 reveals the turret (without guns) with the dome removed.

Thirty ¼-in. bolts fasten the turret flange to the airplane structure. To complete the installation, the anti-rotation bracket is coupled to the interrupter and the power cable connector is plugged in. Then following installation, the turret is synchronized with the sighting stations by adjusting the Selsyn position transmitters.



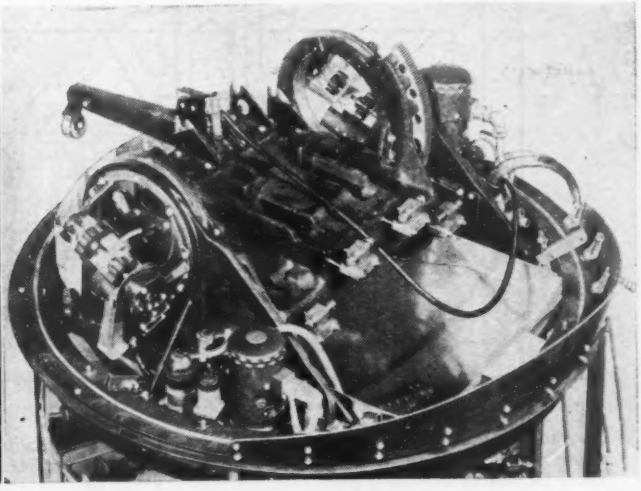


Fig. 16. (left) Close-up photo shows upper half of gun enclosure being removed from turret. Fig. 17. (right) Numerous details of the various mechanisms come to view after dome has been removed from four-gun turret. Here, guns have been omitted from assembly so that units and fittings may be seen more clearly.

Floating Piston Equalizer Coordinates Hydraulic Cylinders

By ALVIN A. MEDDOCK, *Pacific Div., Bendix Aviation Corp.*

By equalizing action of pairs of hydraulic pistons within close limits, simple device assists correct operation under diverse loads.

SEVERAL UNITS IN AIRCRAFT operate in pairs—landing gear, bomb bay doors and wing flaps, among others. To prevent difficulties or accidents, these parts must operate with equal speed, necessitating some kind of equalizing device.

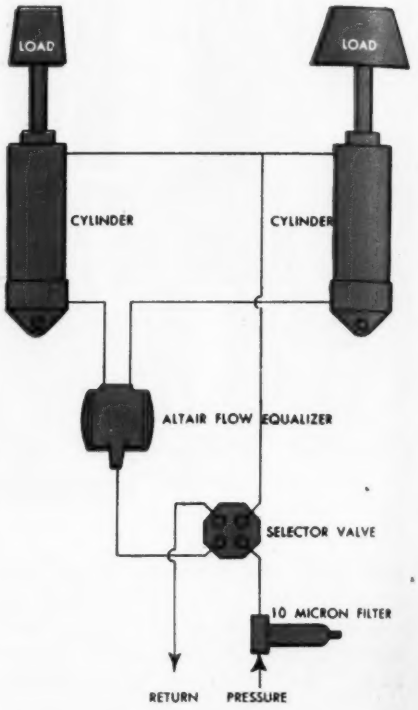
First attempts used rods or cables interconnecting the two hydraulic pistons. However, this arrangement was heavy and threw great stresses on the frame of the ship. Later, a triple-geared regulator was tried, but differences in leakage varied the relative speed of the hydraulic cylinders. Due to the construction, this leakage could not be remedied.

Finally, a floating piston type of equalizer was developed, and this has given great satisfaction under flight conditions. In this Altair-Bendix Flow Equalizer (see accompanying diagram) the fluid enters at (1), pressing the internal plug downwards and opening side ports to passages (2), which lead to both ends of sliding piston (4). Passages (5) lead to the two hydraulic cylinders.

Action is as follows: When flow to both cylinders is equal, then equal pressure on ends keeps piston in central position. Fluid opens valves (3) and flows in equal streams to both cylinders. If, however, one hydraulic piston tends to move faster, through reduction of load, the fluid pressure at the corresponding end of piston (4) will drop, whereupon the piston will be moved in the direction of the end with less pressure, opening slightly the opposite passage and permitting the more heavily loaded piston to travel at the same speed as the other.

At the same time, movement of piston (4) closes slightly the passages to the more lightly loaded hydraulic piston, thereby retarding its movement until both hydraulic pistons operate at same speed. Reverse action is by the two upper valves in piston (4). These allow the fluid to return to the system, while governing its flow in the same general manner as in the case of outward flow of fluid.

Since the movement of the balance piston (4) is not usually more than a few thousandths of an inch, and since this movement only takes place slowly and at intervals, wear on the piston is negligible.



Installation comprising a pair of hydraulic cylinders with equalizer in circuit. Motion in both directions is controlled automatically by one equalizer.

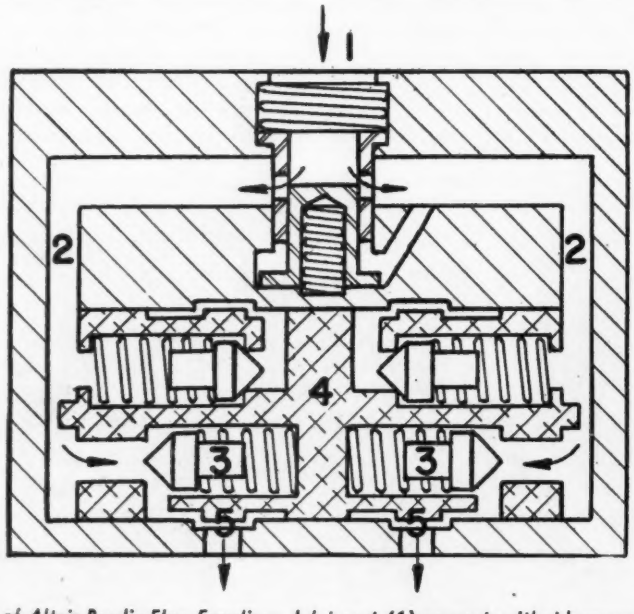
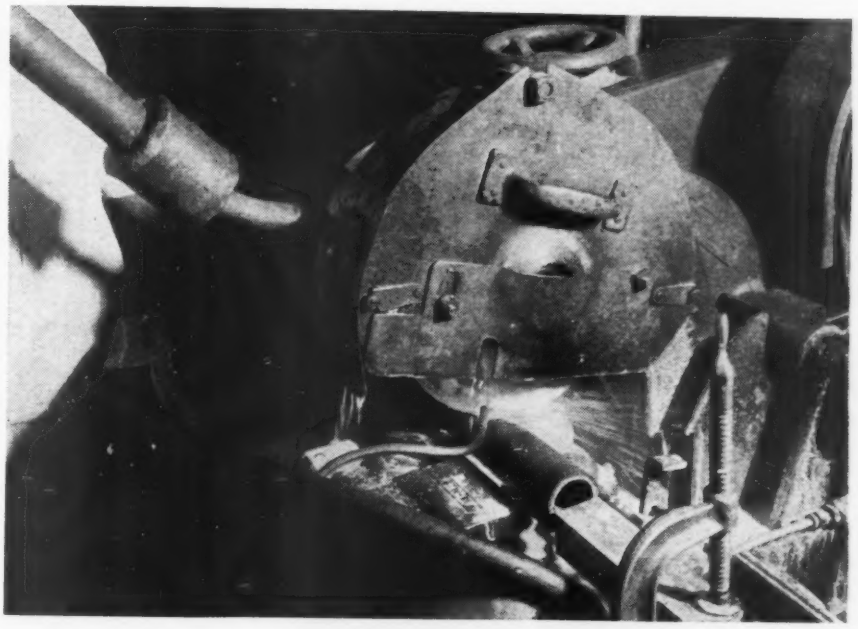


Diagram of Altair-Bendix Flow Equalizer. Inlet port (1) connects with side passages (2); check valves (3), permit flow of the fluid outward to hydraulic cylinders. Balanced piston (4) moves endwise slightly when pressure in either passage is lowered by acceleration of hydraulic piston connected to that end of equalizer through passage (5). Metering grooves are opened or closed by movement of (4), thus equalizing flow at both ends.

Gear-type equalizer formerly used to equalize flow of two streams of hydraulic fluid. Since gears turned at same speed, they were supposed to pass equal quantities of fluid. But this function was considerably affected by wear of the parts.

PLANT PRACTICE HIGHLIGHTS



Disk Cutter Slices Asbestos Hose Cleanly

• Substituting a soap-lubricated disk for the conventional circular saw, when cutting lengths of asbestos-covered hose, Curtiss-Wright Buffalo plant saves over $1,300 per year. Additional advantage is that disk cuts asbestos cleanly, without fraying material. This avoids accumulations of lint inside tubes, which formerly required an extra cleaning operation.

Balanced Hoist Adds Safety, Reduces Manpower

• Whereas an extra man was formerly required at Martin's Baltimore plant to assist in lifting heavy steel beams used on bomb bay door jigs, this work can now be done with one hand, through introduction of counterbalanced hoists which carry the weight formerly lifted by two men. In addition to this advantage, beams are now retained overhead by the hoists, instead of being laid on the floor where they might be an obstruction to free passage.

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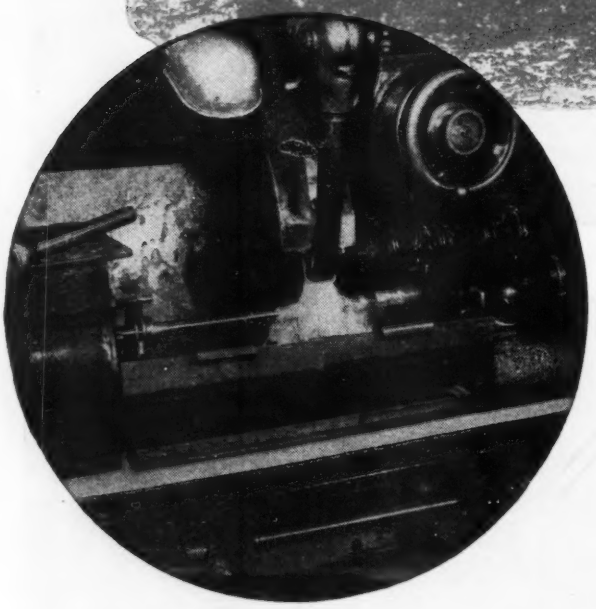

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- ★ Prolong tool life

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Texaco Cutting and Soluble Oils are typical examples of petroleum products improved through The Texas Company's constant research. Texaco cutting fluids, each designed especially to improve the efficiency of a particular type of cutting, are produced by modern Texaco methods in one of the world's largest refineries . . . and absolute uniformity is assured by skilled technicians who supervise every step of production from well to finished product.

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RECONVERSION RUSTPROOFING

4 Points to Remember

1. Ordnance Specification P. S. 300-4 contains *official instructions* for the complete processing of Government-owned production equipment.
2. These instructions require that only rustproofing materials meeting Government specifications be used.
3. *Texaco rustproofing products meet Ordnance specifications for application on Government-owned equipment.*
4. For full information, see your Texaco representative or write to us.

TEXACO

TEXACO CUTTING, SOLUBLE AND HYDRAULIC OILS FOR FASTER MACHINING

TUNE IN THE TEXACO STAR THEATRE WITH JAMES MELTON EVERY SUNDAY NIGHT — CBS

MAINTENANCE

CORRECT SERVICING DETERMINES DE-ICER EFFICIENCY

PART I

As our air travel schedules rocket toward new records, the need for unfailing service from ice-curbing devices is sharply accented, and prescribed is this practical and precise information on maintaining these important units . . . First installment of a timely two-part series.

IN ICING WEATHER, before the invention of de-icers, flying hazards were high enough to cause cancellation of many flights until conditions indicated that the danger from wing icing had abated. But since the application of de-icers to commercial aircraft, accidents from ice accumulations on wings and control surfaces have no longer been considered as major dangers to air traffic.

Because of the long distances frequently covered in single flights, it is possible that atmospheric changes may require airplanes to fly through icing conditions which did not exist when the flight was started. For this reason, it is essential that de-icers should always be maintained at their highest efficiency, and sometimes this means far from their regular repair base. To assist those who find it necessary to perform such service, this series has been prepared by AVIATION.

The typical de-icer consists of a rubber sheet containing inflatable cells or tubes, the assembly being stretched and attached along the leading edge of the part to be protected. Tubes are made of coated, stretchable fabric.

That portion of the de-icer which extends from the air connection to the edges is called the "stretch area". In some types this part consists of a single sheet of rubber, while in others it is made of a heavy sheet of rubber which is backed with light sponge filler and covered with a thin rubber sheet. At the ends and at intervals in its length are pieces of reinforcing fabric capable of stretching in one direction only. This stretch is always across the longitudinal centerline of the de-icer.

Outer edges are equipped with steel reinforcing bead, built into the rubberized fabric. This bead is used for attaching the de-icer to the airplane.

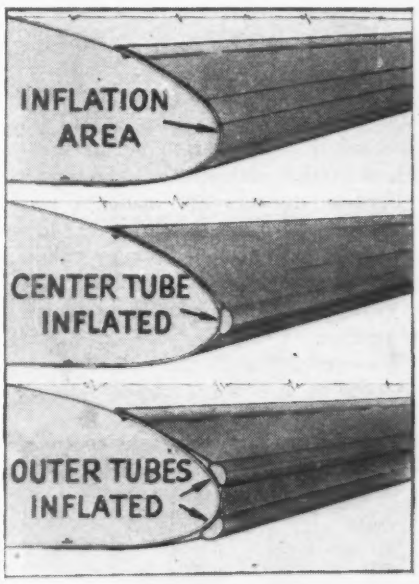


Fig. 1. De-icers consist of parallel tubes on leading edges of wings, etc. They are inflated and deflated rapidly with rest period between inflations.

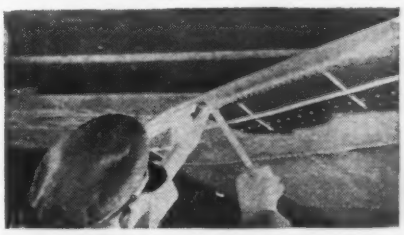


Fig. 2. Before installing de-icers, apply adhesive tape over all seams and rivet heads to prevent wear on under surface of rubber. Use P-27 primer if near salt water.

Fig. 3. Brush a mixture of talc and nonleaded gasoline on leading edge to lubricate underside of de-icer. All parts must be absolutely dry before installation.

A ground check of the entire system should be made every 50 hr. For checking without engine operation, there should be a test plug in each system between check and control valves, connected to air pressure of not more than 10 psi. When the air is turned on, the pump line check valves should close automatically, protecting the vacuum-driven instruments.

After the check valves close, air pressure should be run up to about 8 psi. for inflation of each de-icer. Variations in pressure should be adjusted at pressure relief valve at bottom of final air filter. (For sequence of

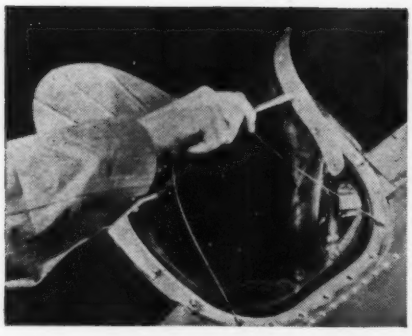


Fig. 4. First step in disassembly is to remove all screws and fastenings holding de-icer in place.

Fig. 5. To remove flap, when used on de-icers, squirt benzol along and under edge to soften cement and permit lifting of flap.

Fig. 6. Tag all fairing strips and other parts as they are removed.

Fig. 7. After disconnecting hose, remove de-icers from leading edge.

inflation, see diagram with each de-icer installation. If inflation is not as shown, discrepancy must be traced and corrected.)

All sumps should be opened and oil blown from drain lines. Because they are governing factors in effectiveness of the installation, inflation and deflation should be rapid and complete. Inspect surfaces for punctures and repair them, if found. Special attention should be given to surfaces close to the framework of the airplane, since static sparks caused by insufficient or incorrect grounding have been found to cause punctures in the rubber. Test system timing through several complete cycles. If complete cycle is longer than 45 sec., determine and correct the tardiness. Normal cycle is 40 sec. Voltage during ground check should be same as that used during flight. Mechanical equipment should be serviced as recommended by manufacturer.

Because de-icers are made of soft rubber to permit stretching at low air pressures, gasoline hose or cables should not be dragged over them and servicing ladders or platforms should be padded.

Remove engine oil from all surfaces as soon as the plane lands. Use a neutral soap-and-water solution. If hard to remove, benzol or non-leaded gasoline may be used sparingly with a soft cloth, but the surface should be dried as soon as possible. Soft rubber should not be *scrubbed* with the solvent. No other cleaning agent should be used unless approved by B. F. Goodrich Co.

Selection of Repairable De-Icers

The prime purpose of repairing being to render the equipment completely fit for further service, careful attention should be given to its over-all condition. If the entire stretch area is checked or cracked to a depth of over .005 in., no repairs should be attempted; but if there are only occasional slight checks, a coating of conductive cement should render them serviceable. If checking is deep but restricted in area, the damaged portion may be cut out and replaced with sound material. De-icers which have swelled or become soft through contact with oil should be scrapped.

For making vulcanized repairs it is recommended that only materials supplied by the manufacturer be used, because these have been carefully selected for their properties of resistance to sunlight and weather, together with retention of flexibility. Because soapstone is used on these materials to prevent sticking together while in stock, they should be carefully washed and dried before using.

Terminology

Explanation of the following terms—most of which have a special application in maintenance—will render instructions easier to comprehend.

Washing. Cleaning surface with clean, soft cloth moistened with benzine, non-leaded gasoline or special cleaning solvent. Liquid should not drip or run over material and should

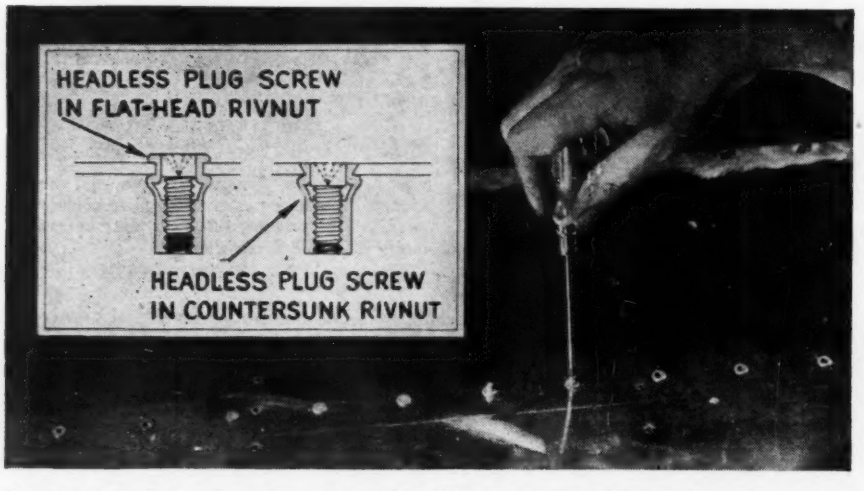


Fig. 8. Unless de-icer is to be replaced immediately, close all Rivnut holes with headless screw plugs.

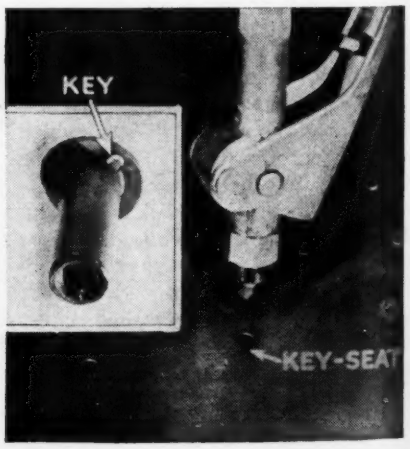


Fig. 9. If new Rivnuts of keyed type are installed for first time, keyseat must be cut with special tool.

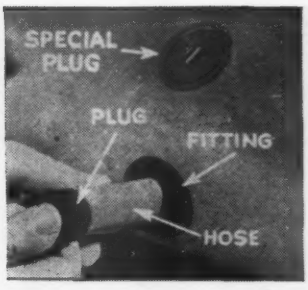


Fig. 10 (left and center). Before storing, tag hose and secure inside wing. Snap summer caps into holes. Where hose is not removed from de-icer, insert plug in hose and push in flush with wing surface.

Fig. 11 (right). Using gasoline or benzol, scrub fairing strips and underside of flaps to remove old cement and primer. Too much liquid will harm de-icer.

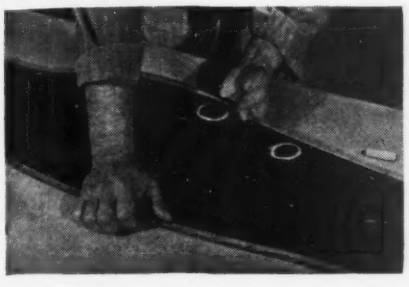


Fig. 12. After stretching rubber to show up holes, carefully inspect surface of de-icer and mark any damage for repairing.

Fig. 13. Top photo: After washing with soap and water, place buffing shield around place to be repaired and (1) roughen with wire buffer, (2) smooth with emery buffer, (3) clean with benzol, (4) remove fabric from patch, and (5) apply No. 1 cement to patch and de-icer. Photo above: Then when cement has become tacky (6) apply patch, (7) clean with benzol, after allowing 15 min. for drying, and (8) restore surface by brushing on conductive cement.

be dried off as soon as cleansing operation is completed.

Rout. To remove rubber surfaces with electrically-driven carborundum stone.

Buff. To roughen surfaces with carborundum buffing stick.

Cementing. Refers to application of two light coats of 50/50 mixture of Nos. 60 and 61 vulcanizing cements, each coat being allowed to dry before next is applied. Other types of cement may be used if specified.

Gum is uncured rubber stock. Where cured stock is to be used, it will be so specified.

Face of de-icer is the exposed side when installed. It is the black, conductive surface.

Back of de-icer is the side next to the wing when installed.

Stitching is the operation of forcing materials together with a metal or wood roller, working from center towards edges to avoid trapping air in the joint.

General Procedure

The repair room should be free from dust and foreign matter. It is important that repair benches be kept clean of small objects, chips, buffing dust, etc., since these easily adhere to the surfaces being worked upon and, if they are introduced into the joint, will cause failure or weakness.

If the repair is to be vulcanized, a fairly large area around the repair must be thoroughly washed and dried before commencing vulcanization.

When routing around an injured place have all cement or other containers covered to prevent mixture of dust with contents. Dirty materials, cement, etc., should be discarded. For the same reason, both bench and materials should be cleansed of dust after buffing or routing.

Completed repairs should be protected from dust by covering with holland cloth fastened with masking tape. Tape should be removed before curing.

Any air blisters, caused by trapped air between gum and fabric or other surfaces, should be removed by inserting a hypodermic needle to draw off the trapped air.

Cements should be of a consistency to permit application of a thin, even coat. If partially set or lumpy, cement should first be thinned with solvent.

Fig. 14. Use sheeted de-icer rubber for large patches with two coats of cement on roughened surfaces. Lengthwise patches must be reinforced with rubberized fabric on underside. Since this fabric stretches only one way, line of stretch must be crosswise of de-icer.

Repairing should not be attempted in temperatures of less than 50 deg. F. When humidity is high, if moisture forms on freshly washed or cemented areas, wipe with a clean cloth slightly dampened with washing solvent.

Fig. 15. Before resurfacing de-icer, scrub with cloth moistened with butyl acetate or isopropyl acetate.

Fig. 16. Mask de-icer label, then spray smooth coat of conductive cement. Badly worn portions may need a second coat.

Fig. 17. Wash off wing with cleaning fluid after removing all protective covering tapes from surface.

When only a small area is being repaired, under unfavorable temperature or atmospheric conditions, if a small canopy is placed over the work, with a lighted electric light bulb inside, the added heat may be sufficient to permit the repair to be completed.

Because of the adhesive condition of most of the materials used, it is essential that hands, benches, and tools be kept as clean as possible to prevent dirt being included between the joint surfaces.

Making Small Cold Repairs

Correct procedure for small surface repairs is as follows:

1. Clean surface around damage with soap and water and wipe dry.
2. Select a patch of correct size.
3. Place shield of size corresponding to patch over surface, exposing area to be patched. Hold shield in place during next four operations.

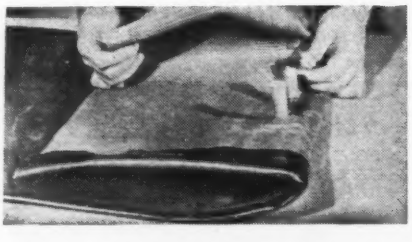


Fig. 18. In preparing for storage, lay de-icer with black outer surface upward. Then tuck flaps under and tape all metal parts to prevent injury to rubber surfaces.

4. Rub with cloth soaked in benzol, to soften conductive surface.
5. Roughen surface with wire buffer.
6. Smooth with emery buffer until surface has been removed .003 in.
7. Clean with benzol and allow to dry.
8. Apply thin coat of No. 1 cement and let dry.
9. Remove fabric backing from patch and apply coat of No. 1 cement to exposed surface. Keep surface clean until dry. Rubber cement, unlike glue, should be dry before applying patch.
10. Stick either center or one edge of patch and work remainder down from first portion, being careful not to trap air in joint.
11. Roll down patch with metal roller.
12. If edges are not tightly stuck down, re-cement and allow to dry. Then roll down.
13. Allow repair to set for 15 min., then wipe lightly with benzol to remove excess cement.
14. Apply coat of Goodrich conductive cement to restore conductive surface.

If damage cannot be repaired with standard patches, repair material can be cut to size from sheet rubber or rubberized fabric supplied by manufacturer.

For damage to fabric reinforcement, or at right angles to center-line of de-icer, or for emergency repairs over $\frac{3}{4}$ in. long, repair as outlined here and reinforce with rubberized fabric on back. Cementing procedure is the same, but two coats are to be used. Fabric is applied with stretch at right angles to centerline of any de-icer equipment.

Handling Small Punctures

Small punctures on cells should be patched on exposed surface, but when cells are cut or torn, reinforcement should be first applied on inside before outer surface is patched.

Sponge-filled de-icers are repaired in a similar manner, but if rubberized fabric is applied to the back, the back ply of gum and sponge should be carefully cut out to fit the reinforcement exactly. Clean and buff lightly the outer exposed surface. Apply two coats of No. 1 cement and let dry. Then apply rubberized fabric as directed. Cover entire repair and seal exposed edges by cementing a sheet of .010 in. cured repair gum over whole area.

The method used in curing vulcanized repairs will be described in concluding Part II of this series, Nov. AVIATION.

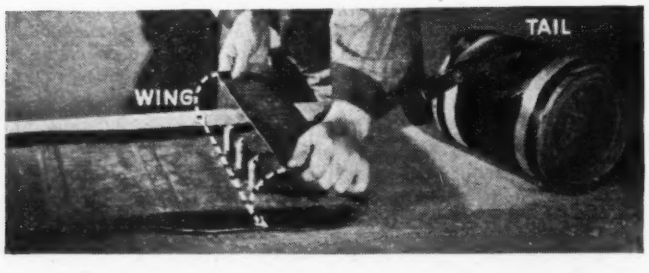
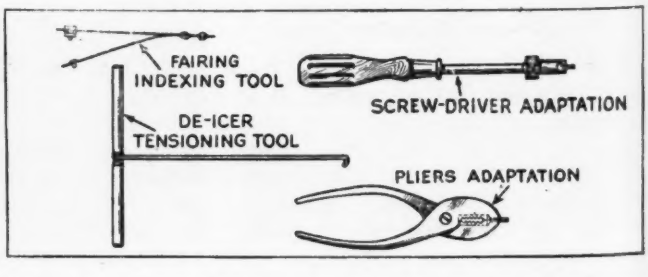
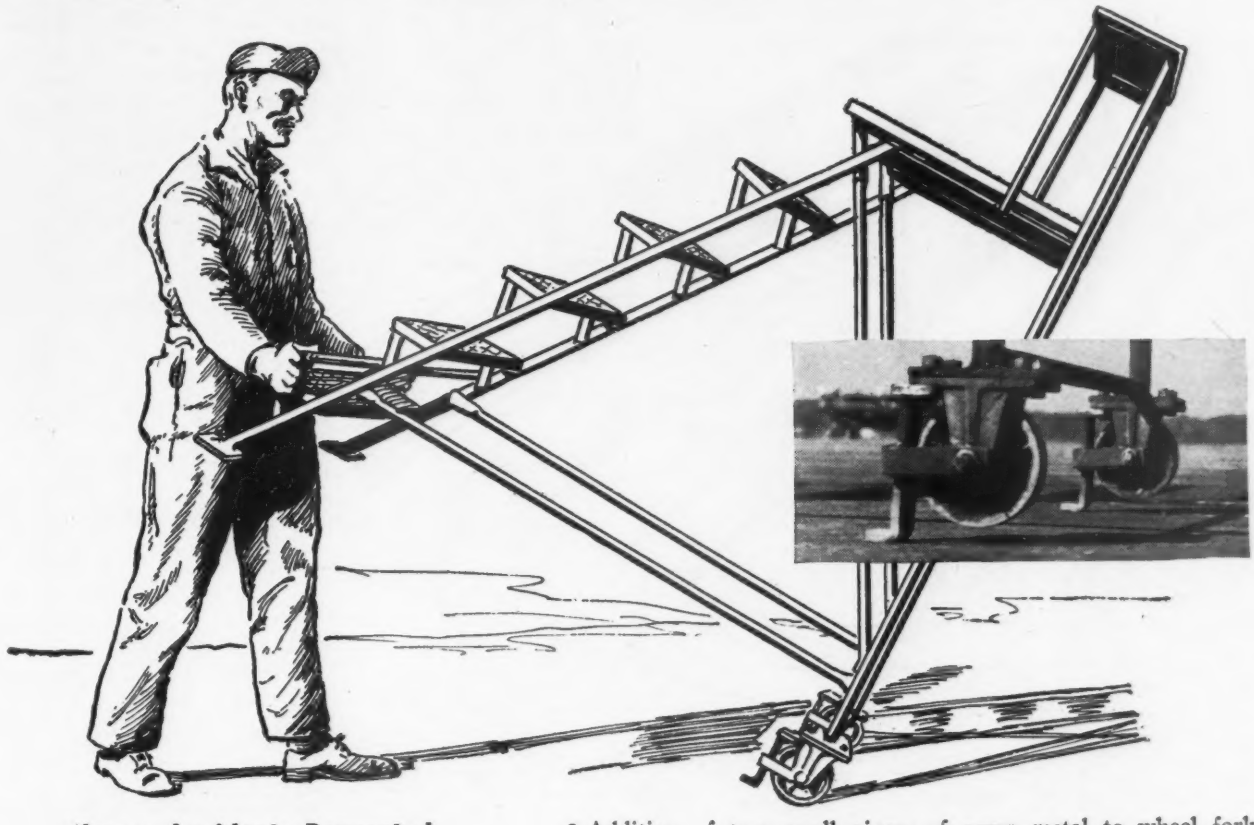


Fig. 19 (left). When thoroughly dry, roll up with inside dia. not less than 5 in. Wing de-icers are to be rolled from connection end, while tail de-icers are rolled from tip. Fig. 20 (right). Special de-icer repair tools. They can be made in any shop.



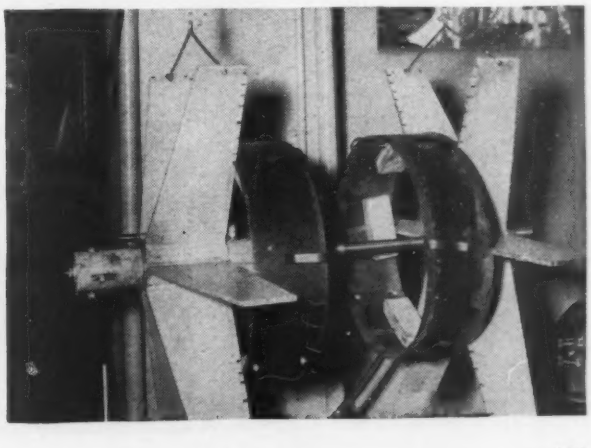


Apron Accidents Prevented By This Non-Skid Ladder

• Addition of two small pieces of scrap metal to wheel forks of maintenance ladders at Glenn Martin Airport has entirely eliminated skidding on concrete surface. Ladder is tilted for moving, and non-skid device automatically immobilizes it when in working position.

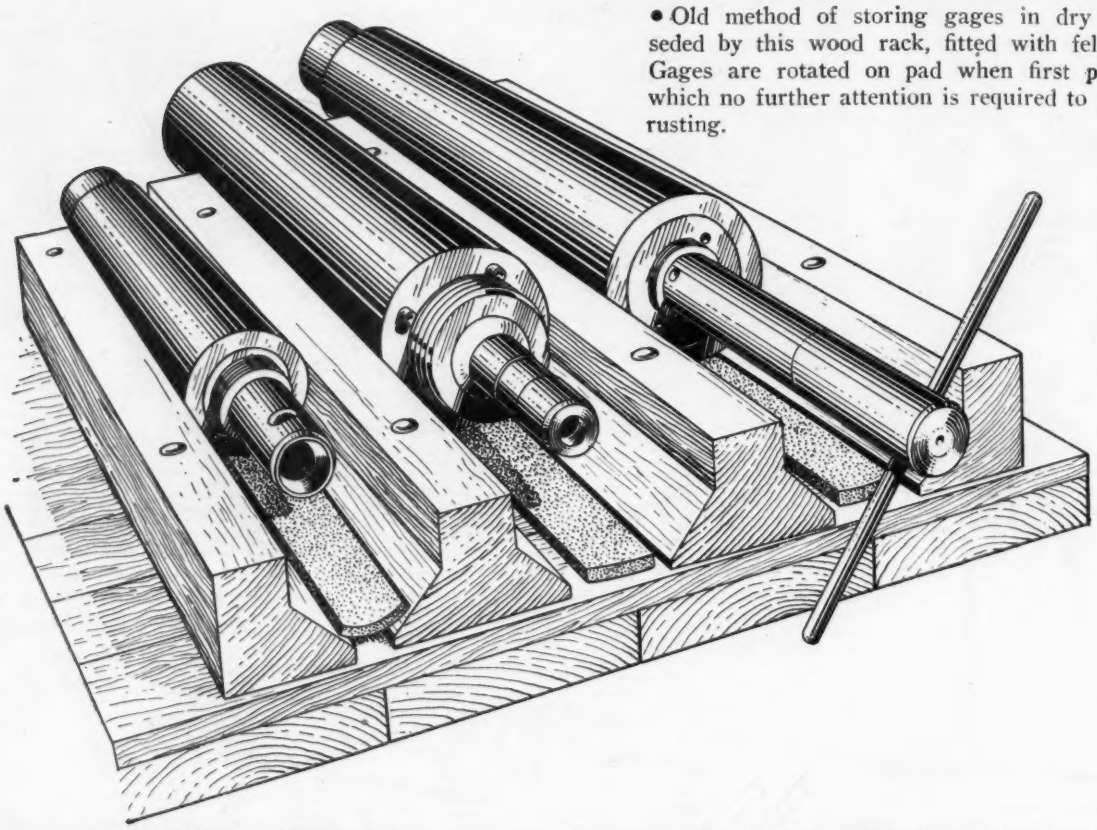
Hydraulic Equipment Eases Wheel Servicing

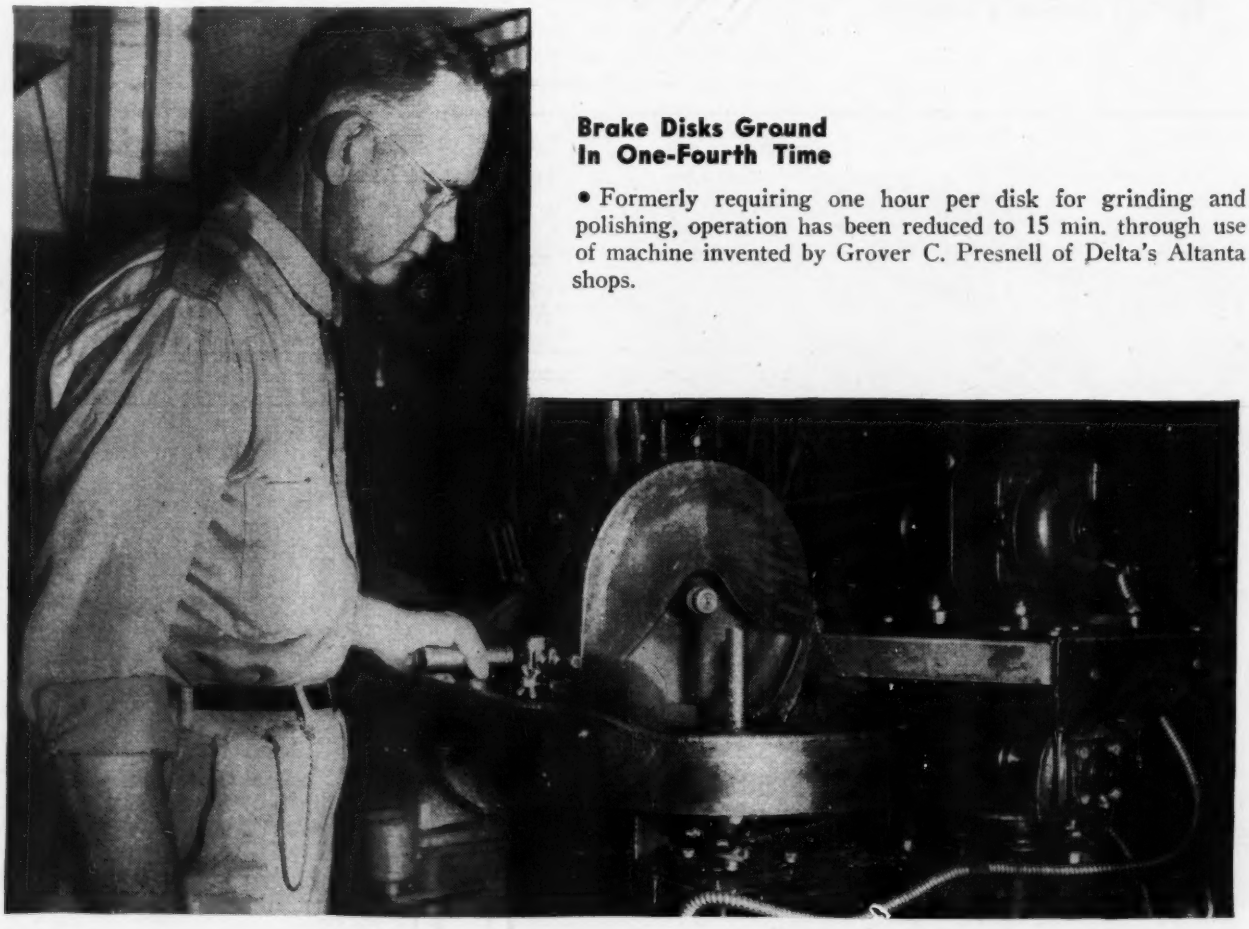
• In this machine, two six-vane brackets, with concentric notches for handling brake or wheel parts, are forced together by hydraulic cylinder when valve is opened by operator. Designed and built by S. S. Watkins of PAA's Miami base, unit has eliminated all heavy manual labor in wheel and tire servicing, since wheel is replaced while tire remains on its dolly.



Padded Rack Carries Plug Gages Safely

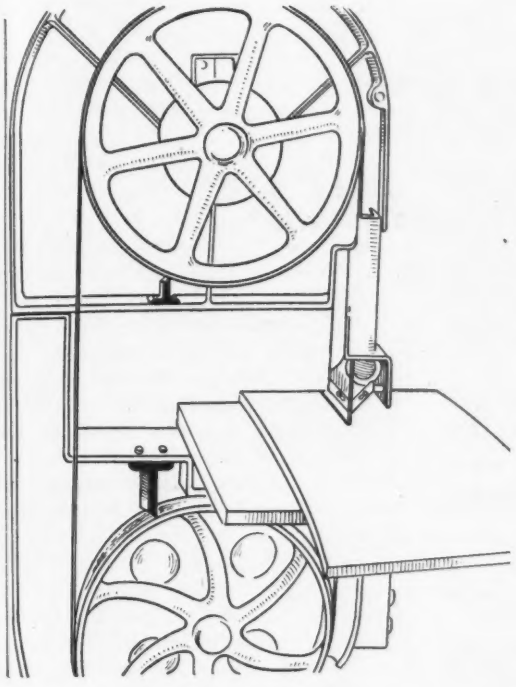
• Old method of storing gages in dry condition is superseded by this wood rack, fitted with felt pad, oil saturated. Gages are rotated on pad when first placed in rack, after which no further attention is required to protect them against rusting.

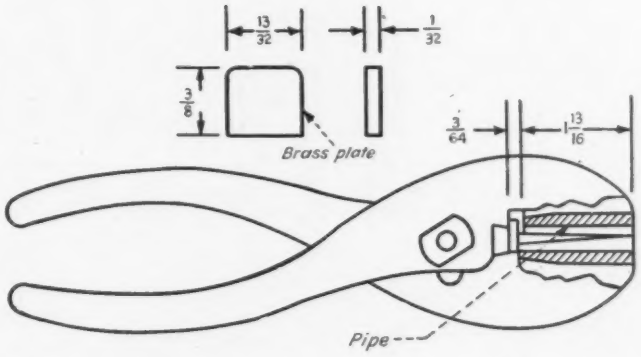




Brake Disks Ground In One-Fourth Time

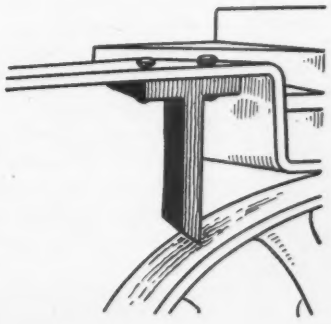
• Formerly requiring one hour per disk for grinding and polishing, operation has been reduced to 15 min. through use of machine invented by Grover C. Presnell of Delta's Altanta shops.





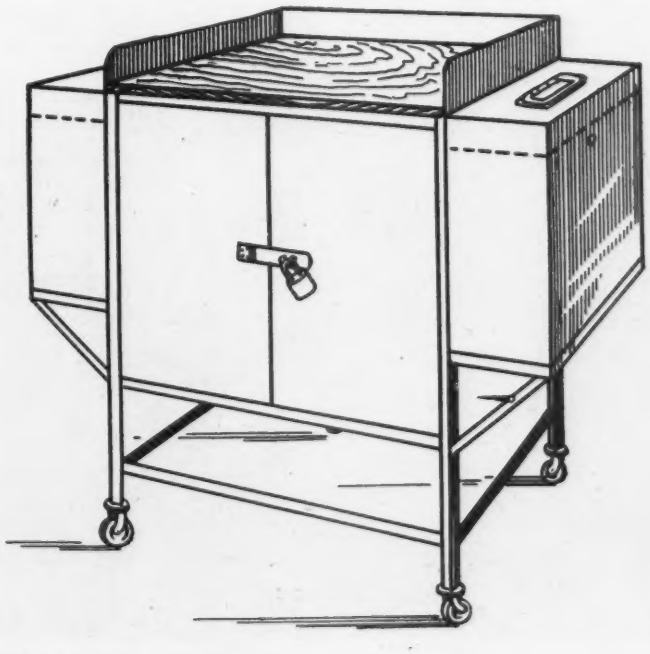
Carburetor Needle Puller Conserves Delicate Parts

• Puller for Stromberg carburetor automatic mixture control needle saves many parts from being injured during removal. Devised by A. G. Beck of Miami ATSC, tool consists of two 7/8 i.d. semicircular pieces of brass pipe welded into jaws of pliers, together with small brass plate welded to lower jaw for needle to back against.



Bandsaw Wheel Scraper Permits Continuous Operation

• To prevent sponge rubber cuttings from accumulating on bandsaw wheels and throwing sawblade out of line, A. R. Cole of Douglas Aircraft attached scrapers to clean both wheels, thereby saving adjustment and cleaning time and eliminating danger of saw breakage. Device permits cutting of any adhesive-nature material, which formerly required lengthier operation.



Easily-Moved Bench Carries Tool Boxes

• Designed to save steps and time, this caster-mounted bench, designed and made by Glenn Moodie of Sullivant Airport, Columbus, Ohio, features shelves for two large steel toolboxes as well as lock-up cabinet in center section for storage of more valuable tools. Boxes on shelves may be bolted down to prevent unauthorized removal.

HE GAVE WINGS TO THE STEEL BUSINESS

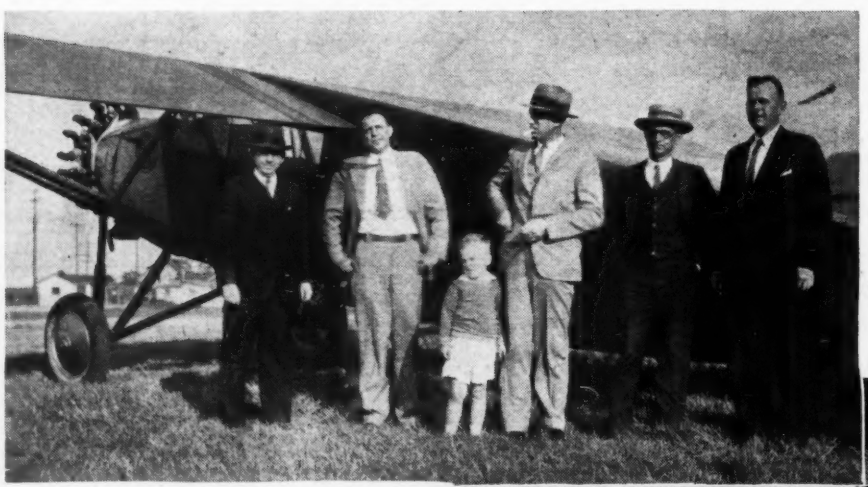
By **EDWARD E. THORP,** *Assistant Editor, "Aviation"*

Sam Keener finds aircraft a prime business essential, right from production on up through sales—and accordingly he believes it's putting it "hindside before" to specify air transport only when ground transport isn't feasible. Instead, Steelman Keener specifies ground transport only when air transport isn't feasible.

A CESSNA UC-78 taxied onto the apron at Youngstown Airport and the pilot climbed out stiffly. "Had a tough ride this time," he remarked. "I sat on a load of pine patterns all the way from Pennsylvania. Had to take out the seats to get them all in."

The plane was one of those owned by the Salem Engineering Co., whose president, Sam Keener, is among the country's most enthusiastic flyers. In his opinion—which he can back up with 25 yr. of experience as a pilot—there are very few fields of business where the airplane cannot be made both useful and profitable. He points specifically to the steel industry.

In the matter of the patterns just mentioned, a contract had been signed for steel castings, but before these could be poured, molds had to made which, in turn, waited on the wood patterns. These patterns could not be started



This 1928 photo shows Wright-engined Stinson J5 which H. H. Harris, of Boston, loaned to Sam Keener (second from left) to stimulate his interest in business use of plane. Plane was used long enough to demonstrate its commercial value, but flying was temporarily abandoned because of inadequate airport facilities. Incidentally, little boy seen in photo, is now in U. S. Army and was German prisoner of war.

Sam Keener and Mrs. Keener leaving Youngstown Airport in UC-78 Cessna with pilot George Cook, formerly of WAL. Plane was purchased to fill business requirements for speedy transportation. (Youngstown Vindicator photo)

until drawings had been completed and specifications drawn up to guide the men who would do the work.

Under the old ground transport regime, this would have meant weeks of lost time; for the men concerned were scattered among widely separated cities. But with the fast twin-engine plane, things moved quickly. Engineers and draftsmen were flown to consult upon and approve the paper work, drawings traveled to the pattern works in a matter of hours, and so the foundry was quickly turning out finished castings ahead of schedule—even the stepped-up wartime schedule.

Many other such instances can be given. Says Sam Keener: "The airplane has been worth so much to this business that we have given up comparing its cost or what it is bringing in. When design changes have to be made, we can fly personnel or drawings; if one of us must rush off to a conference half way across the country, we know he can be sure of returning on schedule, which is another way of saying that we can plan further ahead. We once had an emergency call for a few hundred pounds of spring steel. It had to be in Milwaukee before the next shift went to work—or they wouldn't go to work. So we loaded it up in my daughter's Aeronca, and it was delivered in time.

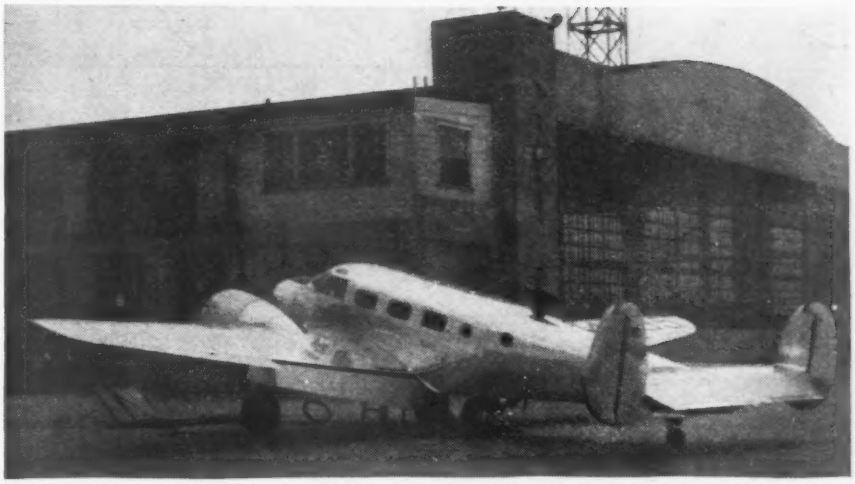
"On another occasion we loaded the Cessna down with steel castings and delivered them to Champaign and Canton to keep things going until the delayed rail shipments arrived. During the winter of '44, whenever transportation was disrupted on the ground by snowstorms, we loaded up enough steel on the planes to prevent plant stoppage and flew it through."

In 1938, Youngstown Airport was purchased for use as a base near Keener's business at Salem. In order to make the airport self-supporting, an aviation school was started, and charter service was inaugurated by Keener's Youngstown Airways.

This may appear at first sight to be a complicated method of using airplanes in the steel business, but the result was a self-supporting airport where the planes of the Salem Engineering Co., and other affiliated companies, could be serviced and with more airport equipment afforded than would have been available on a small, private field.

By 1943 the company owned and used three twin-engine planes—two Cessnas and a Beechcraft, along with two Wacos, and five Taylorcraft for use of personnel on shorter flights.

War production cut down private flying to such an extent that Youngstown Airport was disposed of, though the Engineering company has still continued to keep two planes there and has a mechanic on hand at all times. Peace being back, it's now figured expanding business will necessitate use of more planes than at any time previously.



Requiring fully instrumented plane for all-weather flying, Keener purchased this C-45 Beechcraft, capable of carrying seven people at 190 mph. for long distances.

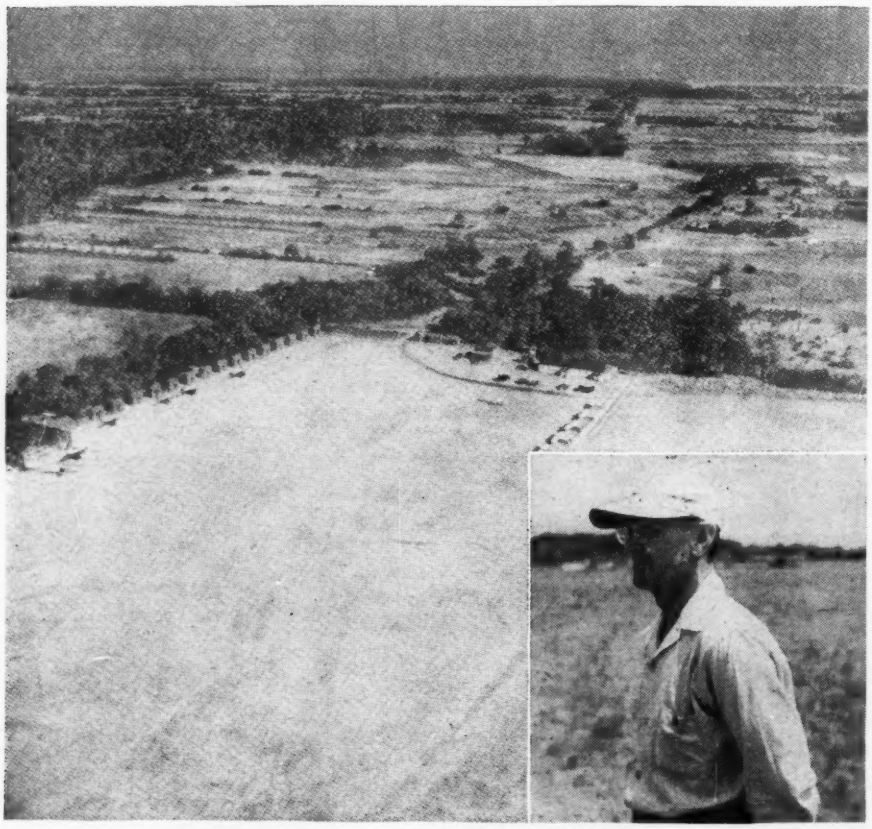
As to the type of aircraft required for business purposes, Keener believes in the 4-passenger twin-engine plane, fully equipped with all instruments required for flying in any weather. Speed should be not less than 175 mph. cruising, with plenty of power to spare. His idea of a business plane is that it must be able to fly at any time or place where an airliner can fly, and it should be able to do this without undue risk.

Sam Keener, who has 5,000 hr. to his credit, contends that all salesmen who have to travel long distances should have instrument pilot licenses. His opinion is that any progressive firm with a large territory to cover will find that a course in instrument-pilot instruction—for all its salesmen and representatives—would be an excellent investment. The Salem Engineering Co. has one salesman with 25-yr. flying experience and another who has flown since 1933. At present they each average 100 hr. monthly.

Sam Keener (right) and Pilot Ray C. Johnson at controls of Salem Engineering Co's Beechcraft.

CSA'S RECIPE For Flight School Success

. . . To one level airport, from which all approach obstructions have been sliced away, add a good brand of tile drainage. Then steam up your basic operations, spice them with special week-day business-getters, keep basting with a practical bookkeeping system —and always serve to the customers' taste.



Pilot's view of tile-drained Carolina Skyways Airport. Office and residence are at center, while hangar is at extreme left. Row of cabins at edge of field were used by CAP. Atlantic Ocean is seen in distance. Inset: William Scott, president of Carolina Skyways.

ON THE WALL of Bill Scott's office at Carolina Skyways Airport, Charleston, S. C., is a graph showing the growth of flight instruction time in hours per month. The first line—made over a year ago—is short, representing only 52 hr. But the latest line, for last month, not only ran the full length of the long sheet but nearly completed a second column. The month's total read 465 hr.

There are several good reasons for this 900% growth. First of all, the field can be used every hour the weather permits, because it is tile drained—really drained. In addition, the runways have been so placed that all approaches are clear of obstructions, permitting their full length to be used.

But it's no good having a nice field if there's not much business. Pilots have to eat regularly, which means that salaries must be paid even at slack times. So "matinee flights" at two-thirds regular rates, were introduced—working on the well-known movie-show principle that many people will attend at otherwise uncustomary hours if the incentive of a bargain is held out to them. As a result, the field is busy all day, every fine day.

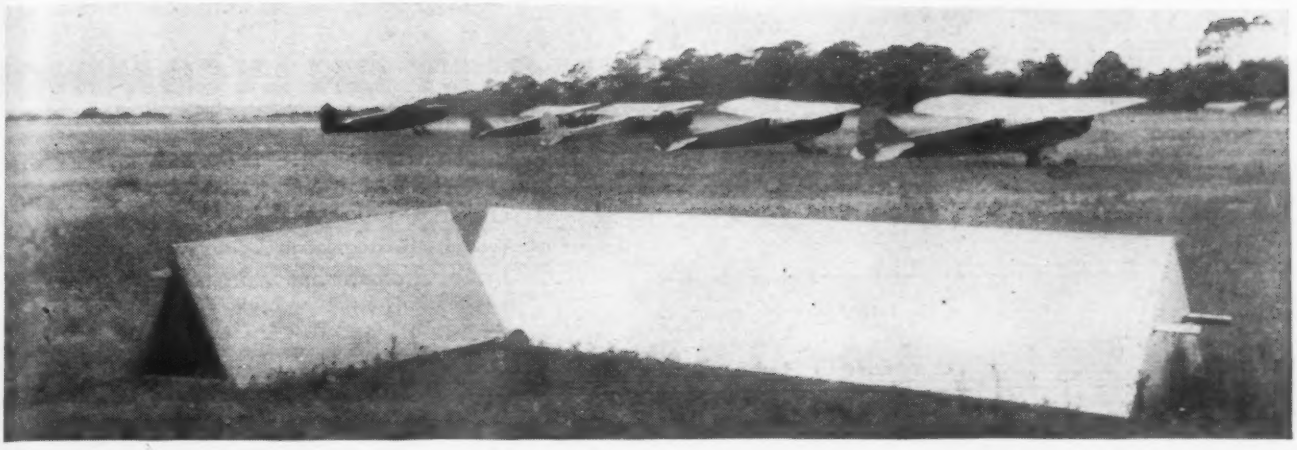
Remembering that many small businessmen have lost out because they failed to keep track of how much came in and how much went out, a simple checkup system was installed using a "flight record" for each day, on which every expenditure and receipt was entered.

Space at the top of the sheet is for entries of fuel meter readings and cash on hand. Below this are columns for NC number of ship; pilot's or student's name; time out and in; total flight time; whether dual or solo; whether paid in cash or charged; amount of charges; and finally a checking column at the extreme right. At the bottom are spaces for night reading of gas meter; gas sold today; total cash today; and a line for the checker's signature.

A similar sheet is used for keeping mechanics' records. Once a month an accountant comes in and posts the books from these sheets. By use of this simple method, earnings of each plane and each department are known and the entire operation is administered on a businesslike basis. Thus if it were discovered that a plane required more than average servicing and repair, it could be eliminated before the profits of another ship would be swallowed up in taking care of it. This feature alone, states Scott, more than pays for the slight added cost of bookkeeping.

The matinee flights built up considerable business, and the fact that one could obtain instruction at practically any hour during daylight soon drew a number of new flight students to the field. Consequently, the original fleet of two Piper Cubs has grown to five. In addition, two Fairchild PT-19's and one Boeing PT-17 have been added, keeping five pilots busy most of the time.

And so, student flight time has gone up fast, at present reaching nearly 500 hr. per month. This, coupled with more than an average amount of matinee solo time, means that the planes are as busy as is consistent with proper allowance for servicing time.



Portable markers can be handled by one man. Long white one is used to designate both runway for landing and direction of wind; shorter section, painted yellow, is placed at side to which traffic is to turn.

Working on an active, three-runway field which has no control tower necessitates some means for traffic regulation. Hence, the marker devices shown in the accompanying photo were made and found very satisfactory. Two light wood frames, one large and one small, were covered with old fabric, and were fitted, wheelbarrow fashion, with handles at one end and small wheels at the other, to allow moving by one man. The larger marker, painted white, is laid parallel with the wind along the approach end of the runway designated for landing. The smaller marker, painted yellow, is placed at an angle to the larger one and serves to indicate the direction in which the air traffic is to turn.

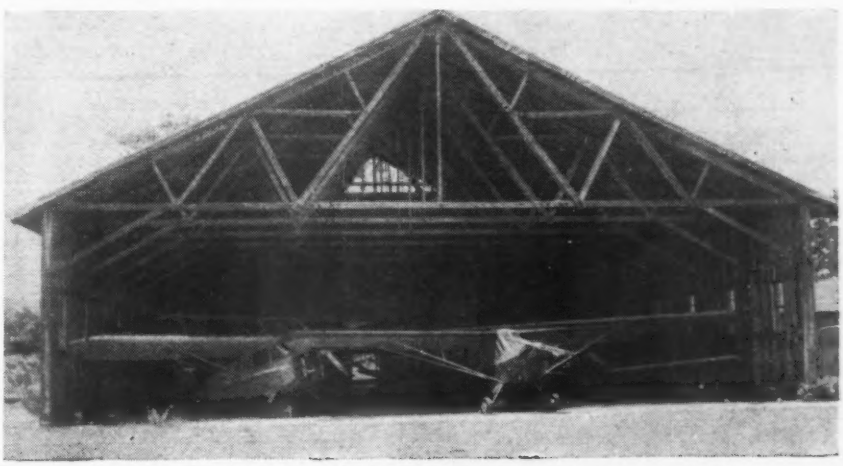
Easily visible from above, this simple equipment has prevented confusion among soloing students, many of whom have a tendency to become forgetful of everything except the ground in front of them when coming in.

Safety, both in dual and solo flying, has been stressed with such success that no accidents have occurred, though the operations record now totals well over 200,000 mi.

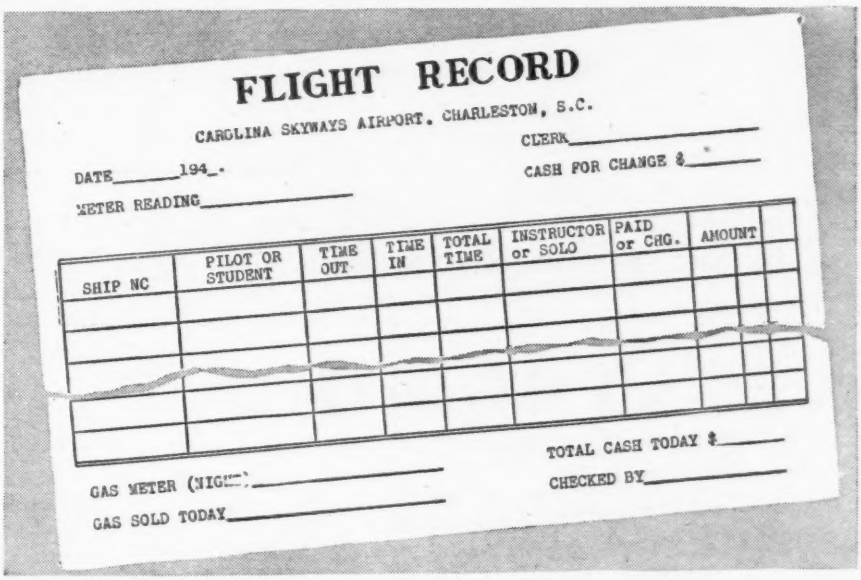
With the field situated only a few miles from the Atlantic coast, the hangar has been framed to weather any storm which may arise. Since it has successfully withstood hurricanes, planes inside are safe at all times, a consideration of importance to visiting pilots who may land for shelter.

Where so many students learn to fly, there is a good market for personal airplanes, so Carolina Skyways is agent for Piper and Cessna, selling planes to those who have been taught to fly. Also, RFC surplus craft have been reconditioned for owners.

Employing the old maxim, "Give 'em what they want at a price they can pay," Scott has used shrewd salesmanship to promote desire in the prospects—then has kept his equipment constantly available to satisfy that desire. Meanwhile he has maintained the health of his thriving business with careful attention to safety factors. And with a practical student-and-equipment bookkeeping system, he not only has kept his entire operation in key trim but has also made sure that no hidden inordinate costs will sap the strength of his services.



Hangar is solidly constructed to parry any heavy winds from Atlantic.



FLIGHT RECORD

CAROLINA SKYWAYS AIRPORT, CHARLESTON, S.C.

DATE_____194_. CLERK_____

METER READING_____ CASH FOR CHANGE $_____

SHIP NC	PILOT OR STUDENT	TIME OUT	TIME IN	TOTAL TIME	INSTRUCTOR or SOLO	PAID or CHG.	AMOUNT	

GAS METER (NIGHT)_____ TOTAL CASH TODAY $_____

GAS SOLD TODAY_____ CHECKED BY_____

Daily work blank for flight records. This sheet, together with another for mechanics' work, also affords complete record of all receipts and expenditures on field. From these sheets, accountant makes monthly posting of CSA books.

Pleasure bent or business bound . . .

More people will rely on planes in the years ahead than you'd have dared guess a few years back . . .

YOU CAN RELY ON LYCOMING!

Which means, of course, that more people will learn to look for and respect *aircraft engine dependability* than has ever been the case before . . .

And this, in its turn, can only mean that the name LYCOMING will come very close to being one of flying America's new household words . . .

Pre-war, at-war, post-war . . . flying dependability is the aim of everyone who works at Lycoming. . . . Pre-war, at-war, post-war . . . performance in the air has proved . . . and will prove . . . that you can rely on LYCOMING.

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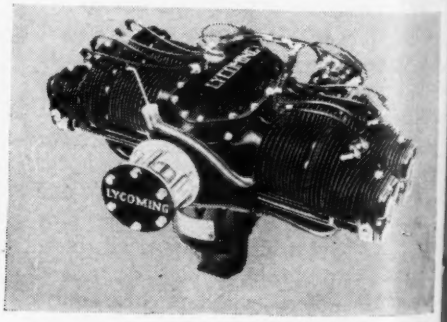

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POWERED BY LYCOMING—THE ENGINE WITH A PROVEN PAST AND A SURE FUTURE

TAGGING THE BASES

WITH CLEAR BUSINESS SKIES ahead, civil operators the nation over are drafting plans and initiating steps to expand their airport services. And pacing this broad postwar move, AVIATION has likewise expanded its "Tagging the Bases" feature—to afford plane and parts makers, distributors, operators, and flyers a valuable business-fostering news-check on growing flight, service, and sales activities.

•

Art Hyde, of Congressional Airport, Washington, D. C., has now acquired new Hyde Field, southeast of the capital.

Jim Gillespie, of Nashville's Gillespie Airways, has sold his airport on Cumberland River to the city. Only 2½ mi. from Nashville, with 3,500 ft. runways and 12,000 ft. of drainage, this airport is seen as a civic asset. Gillespie will continue to operate at McKellar Airport, Jackson, Tenn.

Ross T. Dexter, of Dexter Skyways, now manages Hornell N. Y., Municipal Airport, also a flight school at Wellsville Airport, plus a light cargo service for local manufacturers. In addition, A & E mechanic instruction is being given at Hornell.

At Twin State Airport, White River Junction, Vt., Bugbee Flying Service has inaugurated night flying training under Chief Pilot "Chuck" Stoddard. Battery lights are used.

Haskell A. Beaton, of Charlotte, N. C., has erected a new office building and concrete hangar. Runways have been leveled and extended 200 ft. He also reports that cross-country charter flights are on the increase.

New Dillant Hopkins Airport, at Keene, N. H., is being operated by Bowman Flying Service as CAA-approved repair station and flight school. Bowman has the Piper Cub agency.

E. G. Hirst, of Liteplane Air Service, Toronto, Can., is developing a field at Sudbury, Ont., first of a projected cross-country chain.

Fly Inn, on a farm near Norwalk, Ohio, claims to be the first exclusive "air stop for eating." A T-shaped private landing strip is featured by the dining retreat, and Parks and Iva Ernsberger, owners, state that as many as eleven customers' planes have been on the field at one time.

Merger of Byerly Flying Service, Mt. Hawley, Ill., and Lee Wagener Flying School, Peoria, has been completed, new company name being Byerly-Wagener. Firm will operate at newly reconditioned Mt. Hawley Airport.

Shawano, Wis., is now operating an airport in connection with resort facilities—hotels, cabins, meals, boats, and fishing. Field offers 80-octane gas and A & E mechanic service. Lake, extending 4 by 7 mi., is good seaplane landing.

CAA fields named below can be had by communities virtually for the asking, provided that adequate landing facilities are maintained. In *Ala.:* Atmore, Gainesville, Greenville. *Ariz.:* Ashfork, Cochise, Deep Lake, Holbrook, Main, Red Rock, Salome, Seligman, Tonopah, Winona. *Ark.:* Arkadelphia, Brinkley, Luxora. *Calif.:* Auburn, Bagdad, Blue Canyon, Delta, Desert Center, Dunsmuir, Newhall, Silver Lake, Trona, Truckee, Williams. *Colo.:* Akron, Alvin, Lamar. *Conn.:* Putnam. *Fla.:* Crestview, Immokalee, Jasper, Titusville. *Ga.:* Alma, Butler, Cochran, Folkston, Jackson, McRae, Siloam. *Minn.:* Frontenac, Madison. *Miss.:* Batesville, Corinth, Forest, Rockport, Tylerton, Zieglerville. *Mo.:* Advance, Brookfield, Knoxville, Luray, Marshall, Neosho, New Florence, Osborne, Tarkio. *Mont.:* Big Timber, Custer, Dell, Dillon, Drummond, Forsyth, Geyser, Lavinia, Livingston, Mildred, St. Xavier, Superior, Townsend, Whitehall. *Neb.:* Big Spring, Brainard, Hayes Center, Overton, Sidney. *Nev.:* Buffalo Valley, Fernley, Gabbs Valley, Humboldt, Mormon, Mesa, Ventosa, Wells, Winnemucca. *Tenn.:* Crossville, Gallatin, Graham, Jacks Creek, Manchester, Morristown, Smithville, Whiteville. *Tex.:* Adrian, Arlie, Austwell, Delaware Springs, Dryden, Hammond, Harpersville, Hawkins, Hudspeth, Navasota, Pampa, Parker, Pawnee, Raymondsville, Salt Flat, San Marcos, Simms, Temple, Twitty, Vernon, Westbrook, Wills Point, Yoakum. *Utah:* Enterprise, Fairfield, Grantsville, Knolls, Lucin, Milford, Promontory Point. *Va.:* Chilhowie, Gordonsville, Lively, Milford, Pulaski. *Wash.:* Easton, Harrington, LaCrosse, Toledo. *W. Va.:* Petersburg, Sutton. *Wis.:* Brodhead, LaCrosse, Lone Rock. *Wyo.:* Buffalo, Douglas, Ft. Bridger, Kemmerer, Knight, Pine Bluffs, Sinclair, Sussex, Wamsutter.

Airway Flight Service at Kansas City, Mo., Municipal Airport, has built nose hangar onto end of office for line service in bad weather. Here, Luscombe craft shows how handy facility is employed.

And following CAA fields have now been reconverted to county or municipal use. *Ala.:* Clanton, Tuscaloosa. *Colo.:* Ft. Collins. *Ill.:* Joliet, Rockford. *Ind.:* Huntingburg. *Minn.:* Willmar. *Mo.:* Kirksville. *Neb.:* Chadron. *Nev.:* Battle Mt. *N. Y.:* Glens Falls. *N. D.:* Valley City. *Ohio:* Newark. *Okla.:* Ardmore. *Pa.:* Black Moshannon, Cove Valley, Lancaster, Mt. Pocono. *Tex.:* Kingsville, San Benito, Sulphur Springs. *Wyo.:* Medicine Bow, Wheatland.

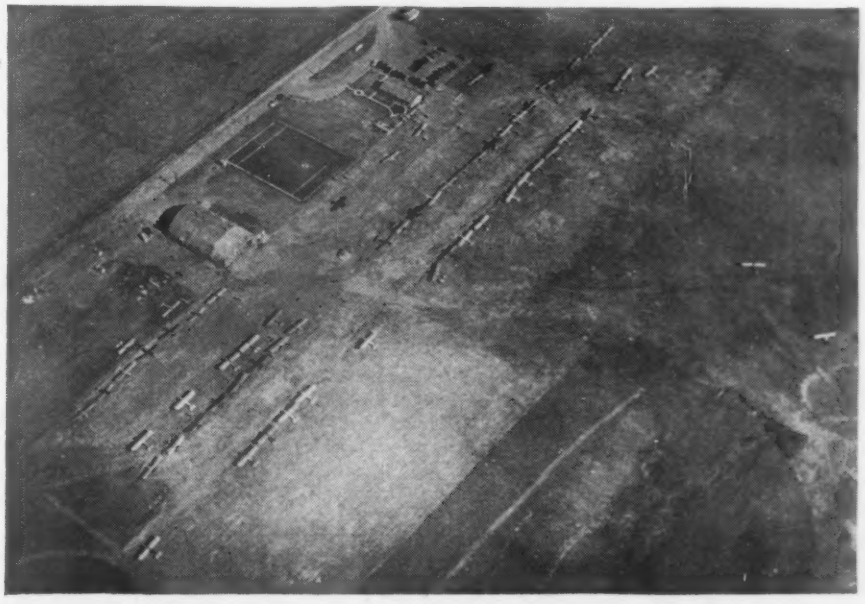
At Prosser, Wash., Glen Lamoureaux and Ken Davidson, of L & D Flying Service, have organized X-C group flights to various airports about 150 mi. distant. Round-table discussions are held after flights to check on experiences and pilot errors.

Boot Hill Flying Service, Dodge City, Kan., is now under management of Roy O. Mahon. Complete flight and repair services are offered.

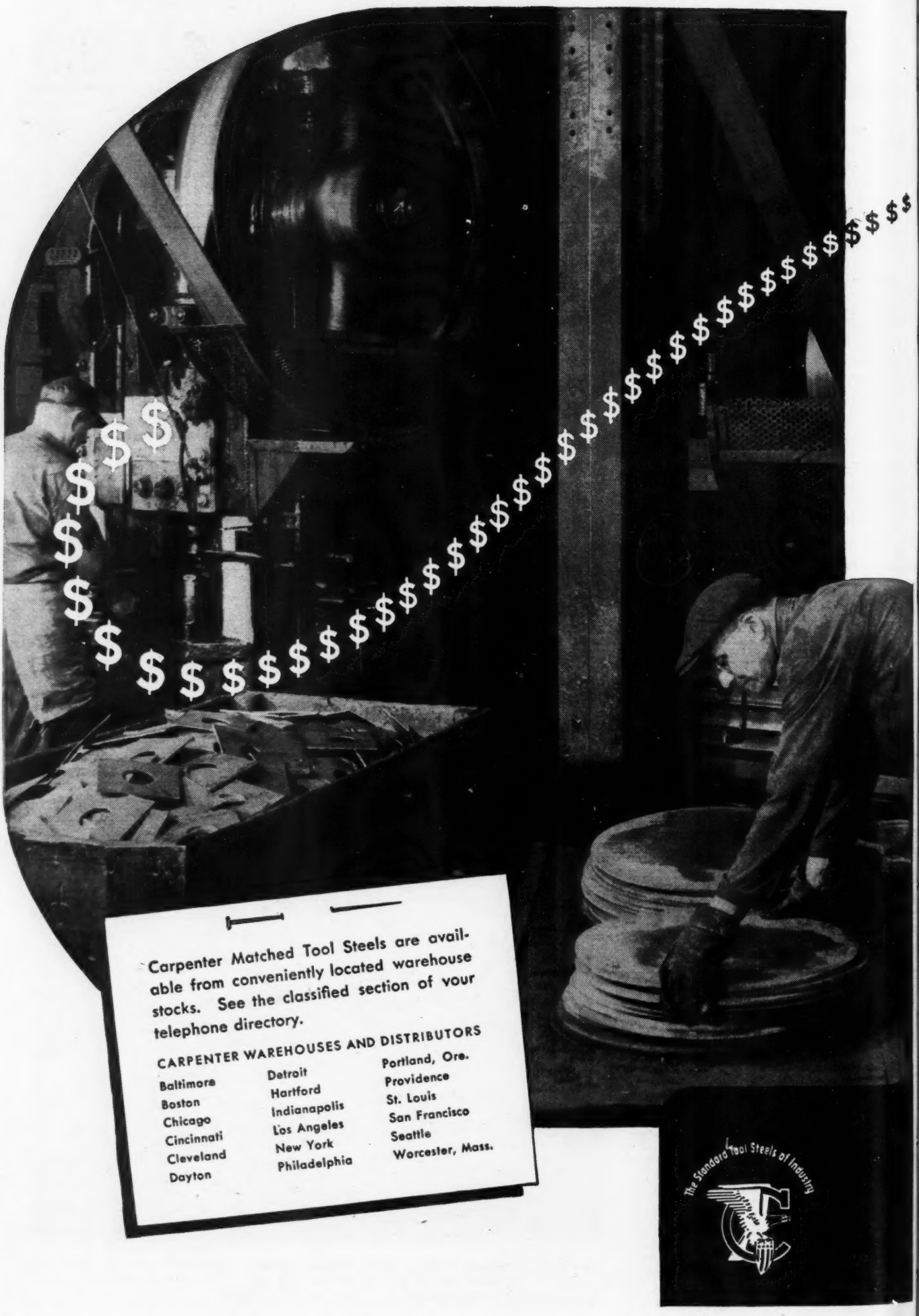
Otto Aviation announces plans for enlarged school facilities at its Lake Susquehanna, N. J., repair base.

Dixie Air, Inc., operated by Raymond Collins, has leased Hargrove Van De Graaf Field, which formerly housed Tuscaloosa, Ala., aviation school for women.

Clinch Flying Service, North Platte, Neb., recently celebrated its 7th birthday. Starting with $100 loan, business now operates Class IV field where UAL averages 14 stops daily. Firm owns 33 Taylorcrafts.



When Flying Farmers of Oklahoma recently staged a meeting at Stillwater, some 130 pilot-farmers dropped into rendezvous field at A & M College. This sky view of gathering demonstrates that traffic capacity of smaller airports has by no means been reached.



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The Standard Tool Steels of Industry

How Your TOOLS & DIES Can Save You EXTRA DOLLARS Every Month

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Tooling costs go down when you put this 3-step *job analysis* plan to work. Watch production costs drop as machines and presses stay on the job more hours every month. Use these three steps to stop the loss from tools that wear too rapidly or fail prematurely.

1. Plan Tool Performance Before Tools Are Made

Now you can spot the way to more wear resistance, greater hardenin accuracy or greater toughness in a tool. With the Carpenter Matche Set Method you can get tools that reduce costs by staying on the jc longer. Put it to work now by using the 167-page Matched To Steel Manual. It shows you how to save time, tool steel and money i solving over 90% of your tool room problems. The Manual is fr to tool steel users in the U. S. A., so for your copy drop us a no on your company letterhead.

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Proper heat treatment is the second step to better tools that cut costs. To get the heat treating results you want, use the "Matched Tool Steel Manual". It contains the most complete heat treating information available in printed form. And as a special help to your heat treaters, we have prepared a handy slide chart that condenses the basic heat treating information and puts it in easy-to-use form. Drop us a line and let us know how many Carpenter heat treating slide charts you will need.

3. Check Costs By Output Per Grind

In the competitive days ahead, costs will have to be cut. But, cos skyrocket and output slumps when tools fail prematurely in servi or need too frequent regrinding. So keep a record of the resul from each tool set-up and use it as a guide to get more output, low costs. And if you want shop help with new tool steel problem call your nearby Carpenter representative. He can work with yo to reduce costs all along the line.

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Carpenter MATCHED TOOL STEELS

MILITARY

NAZI JET-BATS WHICH NEVER TOOK WING

By **ERWIN J. BULBAN,** *Editorial Assistant, "Aviation"*

These two- and three-place high performance twin-jet fighter craft were designed as Hitler hope for regaining air supremacy. Among novel devices planned were use of leading edge flaps and combination ailerons and elevators.

NARROWNESS of the margin by which the Allies held aerial supremacy over the Nazis at the end of hostilities is only now being appreciated.

Vast amounts of data together with aircraft, engines, and armament have been uncovered by Technical Air Intelligence teams. Many of these new air weapons were ready, or nearly ready, for production in underground factories. And, given the results of their findings thus far, many authorities have expressed the belief that if the war hadn't ended when it did the Nazis soon would have had a good chance of stemming the Allied tide, at least temporarily.

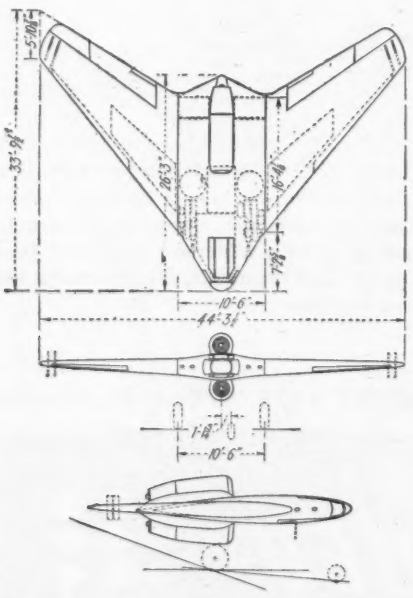
Among the radical aircraft designs discovered are a series of three fighter plane designs on which Gothaer Waggonfabrik (Gotha) had been busily engaged, designated the P-60A, P-60B, and P-60C. The first of these was to be powered by two BMW 003 jet units and would carry a crew of two in prone positions. Takeoff weight was planned at 16,424 lb., wing area at 503.7 sq. ft., and top speed was estimated at 593 mph. at 4,375 ft. Landing speed would have been about 93 mph.

Slightly larger, but with a similar crew arrangement, the P-60B was to be powered by two Heinkel Hirth Oll engines. Takeoff weight was to be 22,046 lb., wing area 587.7 sq. ft., and top speed was planned at about 625 mph. at 3,760 ft. Landing speed was calculated at about 95 mph.

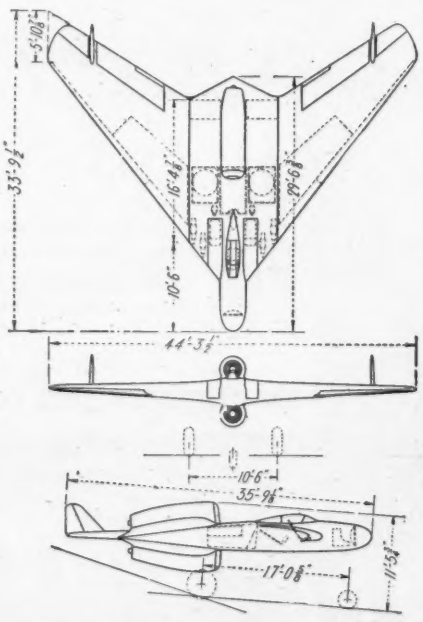
Also powered by two **Heinkel** Oll's, the P-60C was designed as a three-seat night-fighter. Since this craft was to be fitted with a 3-ft.-dia. radar scanner, it was necessary to extend the nose and add a cockpit canopy which would have permitted the crew to sit upright.

All three craft were to have retractable tricycle landing gear and pressure cabins. In addition, a Walter-type rocket motor of 4,409 pounds-thrust was to have been attached for takeoff and climb.

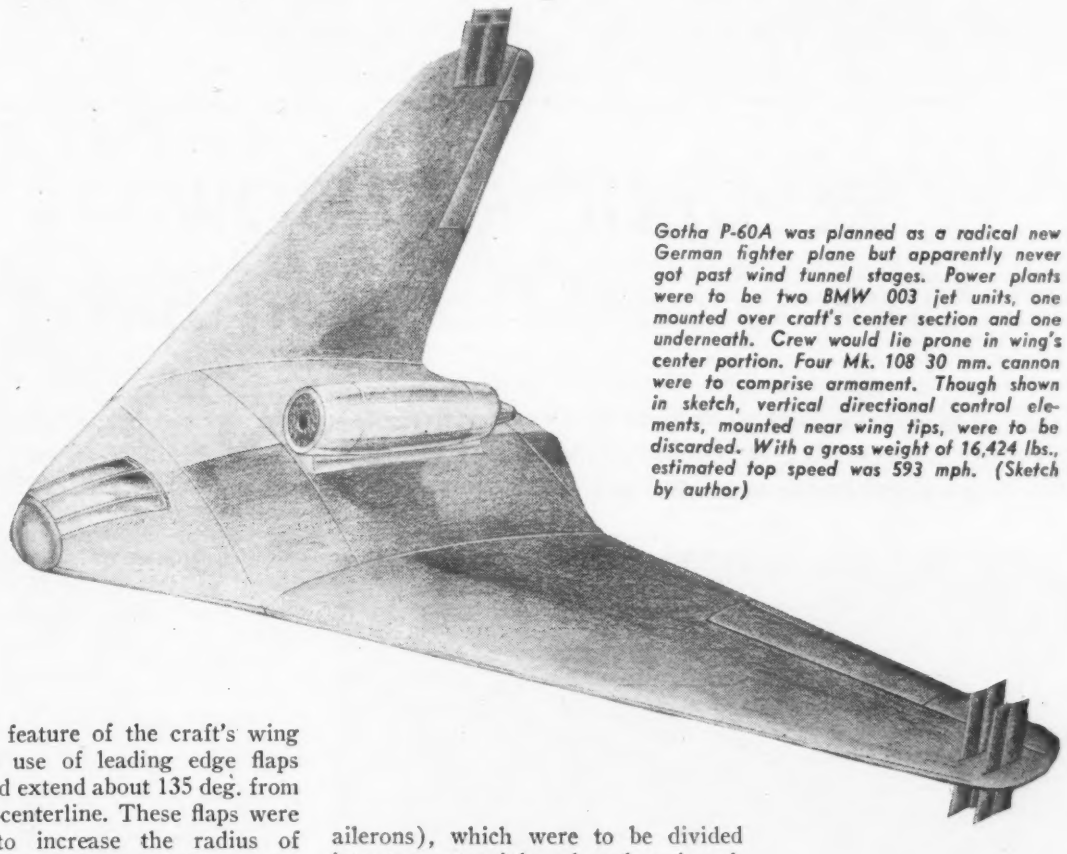
NACA sections were planned for the wings, with the center section to use 0012.5-0.825-35 airfoils, and with outer root panels of 0012-055-50, and tip sections of 0010-1.1-30. Maximum thickness was to be 40% at the tips, but it is reported that this point was later moved forward to 30%. Taper ratio was to be 0.36. A symmetrical profile was decided upon because of its high speed characteristics, especially in view of moment, and with consideration for ease of construction. The Germans believed that a sharp nose would give higher critical Mach numbers, especially at high lift coefficients. For improvement of control surface characteristics, maximum thickness was distributed from 50% chord at root section to 30% at the tips. Dihedral was to be 1 deg.



Plan of P-60B shows that craft would have been similar to P-60A, although former was to be slightly larger. Seating and armament was also to be same, but engines would have been two Heinkel Hirth Oll's rated at 2,860 lb. static thrust each. Note placement of leading edge flaps.



P-60C was designed as a three-seat night fighter to be powered by two Heinkel Hirth Oll jet units. Equipment was to include a large radar scanner which, by necessitating extension of nose, would have given space for conventional upright seating arrangement.



Gotha P-60A was planned as a radical new German fighter plane but apparently never got past wind tunnel stages. Power plants were to be two BMW 003 jet units, one mounted over craft's center section and one underneath. Crew would lie prone in wing's center portion. Four Mk. 108 30 mm. cannon were to comprise armament. Though shown in sketch, vertical directional control elements, mounted near wing tips, were to be discarded. With a gross weight of 16,424 lbs., estimated top speed was 593 mph. (Sketch by author)

A novel feature of the craft's wing was to be use of leading edge flaps which could extend about 135 deg. from the airfoil centerline. These flaps were designed to increase the radius of curvature of the nose in addition to increasing camber, thus to slow the separation of flow on the upper airfoil surfaces. It is stated that these flaps would allow favorable stalling characteristics at the stalling point. Another advantage: There would be no modification in either trim or slope of the moment curve at the high lift range.

An interesting mechanism which would have been utilized to take care of aileron control forces in case low speed lateral stability proved unsatisfactory was an automatic device to artificially produce lateral stability. Using a yaw vane indicator, it would be in the form of an aileron actuator to cause a rolling movement in the desired direction.

No vertical tail surfaces were to be fitted to either the P-60A or B, since it was believed that the cleanness of these designs, together with the vertical fin effect of the engines, would give satisfactory directional stability.

However, it was decided that the enlarged nose section and cockpit canopy on the P-60C would cause turbulence, therefore vertical fins and rudders were designed to be fitted on the wings between the control surfaces. These were to be set in from the tips so that the fins could be used to straighten out the cross-flow on the rear section of the swept-back wings. This location would also have less effect on damping roll and so allow greater rolling speeds.

Control surfaces would consist of elevons (combination elevators and ailerons), which were to be divided into two sets, inboard and outboard. The outer set was intended for use at only high speeds, though both sets could be used at low speeds. The outer elevons were to be linked directly to the pilot's controls, but the inner set would be actuated by a servotab with force exerted on the tab only. Thus, the inner elevons would be allowed to float freely.

Outboard elevons were planned as blunt-nosed Frise-type for best possible effectiveness, hinge moments, and drag characteristics. Aerodynamic nose balance was temporarily set at 26% for the outboard set and 28% for the inboard. Less balance was desired for the outer, since this set would yield the primary portion of the pilot's action, hence the more linear control feel characteristics were sought. The inner elevon would have a Flettner tab which could also be used for longitudinal and lateral trimming.

Rearward, exposed placement of the power plants was decided upon so that engine heat would be kept away from the wing; critical Mach number would be increased by placing the engines to the rear; drag would be lower than that of buried engines, since leading edge ducts would disturb the flow over that portion of the wing; and external mounting would favor maintenance.

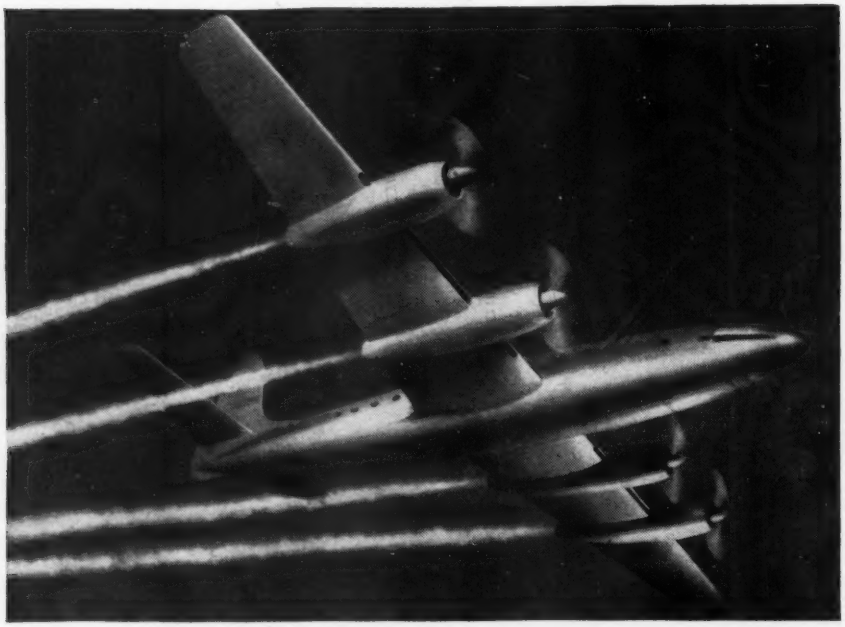
Cockpit layout of the P-60C was to have been of conventional design. However, the P-60A and B were to have hanging rudder pedals and stick, plus a control to separate the tab control mechanism from the stick. It was believed that no pilot discomfort would be experienced using prone positions in flights of up to 3 hr. duration. This had been tested by DVL, the German research laboratories, in a plane especially built for this purpose. For longer periods it was considered desirable that two pilots be used. It was stated that lack of rearward vision would be compensated by the P-60's high speed.

From the evidence gathered it appears that no full scale aircraft of any of these types was ever built and flown. The P-60C design was entered in a German night-fighter competition against seven other craft (including two tailless types) entered by Arado, Blohm & Voss, Dornier, and Focke Wulf.

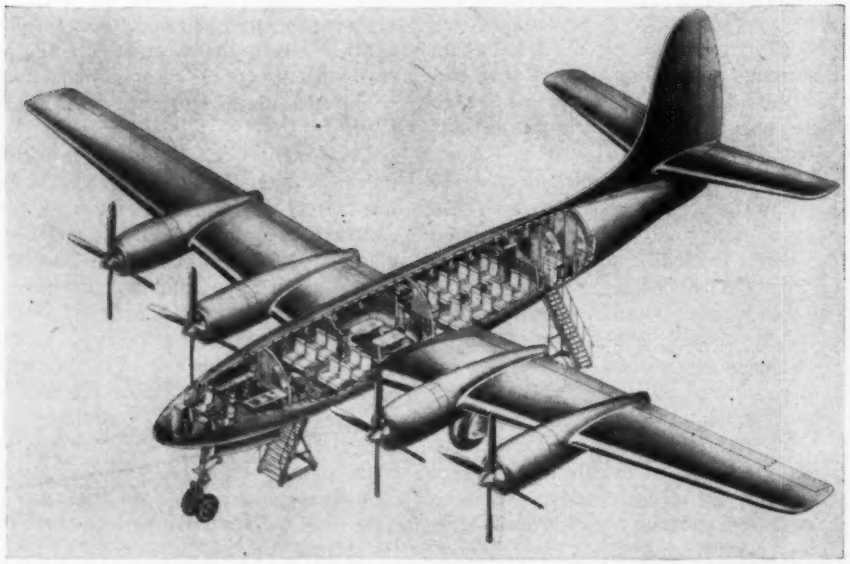
Previously, Gotha had been working on the Horten Brothers 229, also a flying wing. Horten had obtained this contract by going directly to the German Air Ministry. However, since the firm did not have sufficient production facilities, the Ministry ordered Gotha to proceed with the design. Gotha built the 229 V-4 (V means *versuchs*, or experimental), also a center section for the V-5, as well as starting construction of the V-6 and making detailed plans for the V-7 and V-8. Little data is as yet available on these craft. The only 229 to be flown crashed on its second flight.

REPUBLIC RAINBOW
New Global-Transport Bid

New 400-mph.-plus 40-seat craft planned as de luxe carrier for long range operations. Interesting feature of high-powered transport is provision of jet-assist boosters to add 800 hp.



Artist's conception of Republic Rainbow depicts craft in flight at high altitude. Vapor trails behind each engine are effect of jet exhaust boosters, each of which will add an estimated 200 hp. per engine. Top speed is calculated at over 400 mph., and craft is to operate at about 40,000 ft.



Cutaway drawing of proposed Rainbow transport shows interior seating arrangement for passengers and also cockpit layout. Between two cabins may be noted cocktail lounge, which is to seat eight. It is stated that pressurized sound-proof cabin will also contain facilities for showing motion pictures, air-to-ground telephones, and complete dining accommodations. Note long-span split-edge flaps and short ailerons.

NAMED THE RAINBOW, a new 400-mph.-plus transport, slated to carry 40 passengers is now under development by Republic Aviation at Farmingdale, L. I., N. Y. One of the craft's features will be boosters which, fitted to each of the four 3,000-hp.-plus P&W Wasp Major R-4360 engines, are to add a total of 800 hp. through jet assist. Four-blade propellers will be used.

A crew of seven is planned, and it is stated in addition to pasengers the Rainbow will carry 1,600 lb. of baggage and 1,700 lb. of cargo. Landing gear is to be of the fully retractable tricycle type, with dual wheels featured in the nose gear.

A luxurious noise-proof pressure cabin has been planned for long distance traveling at high altitudes. It is to contain complete dining facilities, a lounge, a bar, plane-to-shore telephones, motion picture facilities, and fluorescent lighting. Also, there is to be thermostatic control of the craft's interior.

Clean lines of the oval-shaped fuselage will be topped by a single fin and rudder. One passenger entrance will be located on the right side near the wing's leading edge and another is to be placed on the left side behind the wing.

A measure of the new craft's estimated performance may be gathered from schedules compiled by the company: N.Y.C.-London or the Continent in 9 to 9½ hr., N.Y.C.-Mexico City in 5 hr., San Francisco-Honolulu in 6½ hr., and from the West Coast to the Orient in 15 to 16 hr.

Mammoth Hughes H-4 Nears Takeoff Line

First structural details on what is slated to be world's largest all-wood flying boat freighter. In addition to solving craft's unique construction problems, company's engineers have at same time introduced several innovations in control systems.

A PARTICULARLY INTERESTING aircraft development—because of its all-wood construction and great size—the Howard Hughes H-4 (formerly known as the Hercules) 200-tons-plus cargo flying boat is now in the final stages of completion at Culver City, Calif.

When assembled, the giant craft will span 320 ft., and the hull will be 220 ft. long, 30 ft. high, and 25 ft. wide. Eight 3,000-hp.-plus P&W Wasp Major R-4360 engines will turn 17 ft. 2 in. four-blade propellers. Fuel will be carried in 14 tanks, each holding 1,000 gal., about 42 tons of gasoline. Estimated performance figures for the H-4 are a 218 mph. top speed at sea level, 175 mph. cruising speed, and 78 mph. landing speed. Takeoff distance is calculated at 5,500 ft.

Factors of Wood Construction

A critical shortage of dural and aluminum at the time the contract was being negotiated decided the use of wood. Utilizing the Fairchild Duramold lamination process, birch is mainly used, although spruce, poplar, maple, and some balsa for fairings, also are employed.

All birch parts are built up from glue-laminated veneers, varying from $\frac{1}{64}$ to $\frac{1}{8}$ in. thick. Great length of most parts made it necessary to scarf ends of veneers together before lamination. Birch billets for wing spars are 6 in. by 8 in. by 90 ft.

Special scarfing cutters and presses had to be designed and built. In laying up billets, veneers were scarfed together selectively so that glue lines of excessive thicknesses would not culminate because of variations of thickness in adjoining veneers. All wood was preconditioned before use, then gluing was done in buildings where a constant humidity and temperature of between 72 and 80 deg. was maintained.

Glues Used

Three different types of resin glues are used. Plywood is bonded with a phenol formaldehyde resin, cured by heating to 300 deg. F. Laminate members, such as spar caps, stringers, longerons, and stiffeners, are built up of veneers using urea formaldehyde resin that cures at 70 deg. F. or over. This resin is also used in most of the assembly work.

Medium temperature resorcinal formaldehyde type resin became available only after the project was well started. It has been used in making joints in the hull skin. Coloring was added to identify the types of glue after use.

Hull Structure

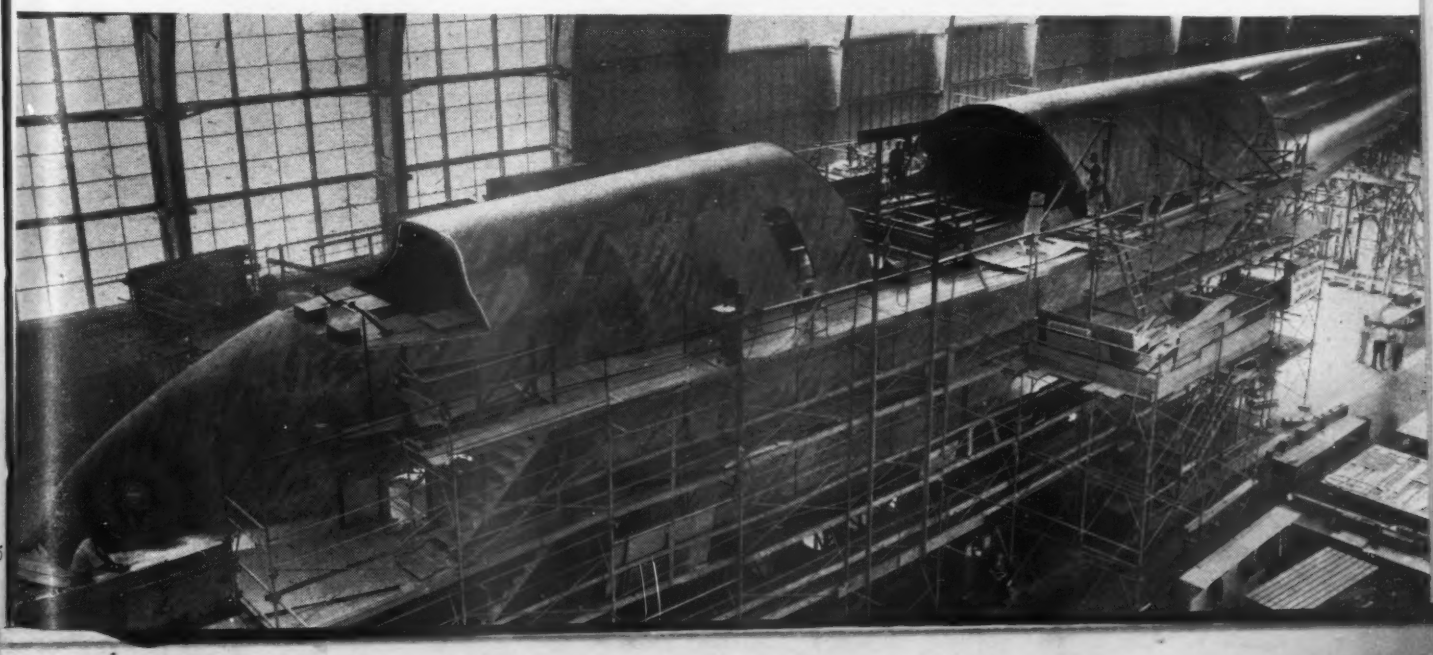
Skin bulkheads and frames are of birch, while stringers are of composite birch and spruce design. The upper longeron is a piece of spruce 10 by 10 in. by almost 100 ft. long. The cargo floor is designed to carry loads of 125 lb. per sq. ft. The craft's bottom skin is $\frac{1}{2}$ in. thick.

Below the cargo deck, the hull is divided into 18 watertight compartments, so designed that even if two-thirds of these were flooded the plane would still stay afloat. Main fuel tanks are housed in these compartments.

Glue pressure for applying the skin was obtained by using thousands of small nails which were removed after

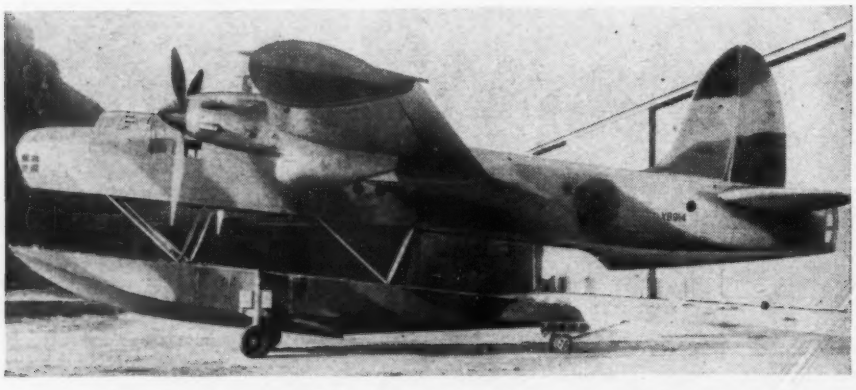
(*Turn to page* 248)

Nearly finished hull of giant Hughes H-4 is seen under construction in jigs. Gap in center is where 320 ft. span wing will be set, and placement of pilots' cabin may be noted near nose. Hangar, especially built for project, is also all wood. It covers approximately eight acres.



Radical Hull Design Tried Out In Blackburn B-20

How this novel military design served to test retractable hull for better flying boat takeoff and flight performance. Stated objectives of craft were to combine proper angles of incidence for takeoff with maximum streamlining while airborne.



Here is Blackburn's B-20 experimental retractable hull flying boat mounted on beaching gear, with outer wing floats in retracted position. Lower hull retracted upward to fit flush with upper fuselage after takeoff. Powered by two 1,720-hp. R-R Vultures, estimated top speed, without guns, was 322 mph.

AN INTERESTING FLYING BOAT development was carried out by Blackburn Aircraft, Ltd., early in 1940. Designated the B-20, 35,000-lb. craft was built and flown incorporating a retractable planing bottom through utilization of a patent by Maj. J. D. Rennie, the company's chief designer. Full details of the scheme are given in patent No. 433,925.

One of the problems facing the flying boat designer is provision of sufficient clearance for the propellers above the water, especially in the case of the monoplane where the engines are mounted in or on the wings. A second difficulty lies in the conflicting requirements for angle of incidence and correct streamlining between conditions of takeoff and level flight. During takeoff, the wing has to be set at a relatively high angle of incidence. It is clear that the inclination at which the wing is normally set on the hull in order to achieve this clearance depends on the running angle of floats or hull. For level flight, however, a much smaller angle of incidence is required, and consequently the seaplane often assumes an attitude which gives higher drag than its form would otherwise have, and much higher than for a comparative landplane.

In Maj. Rennie's patent, the planing bottom of the hull was to be separated from the upper portion by means of links, which were so proportioned that in the lowered position the hull and wings were at the best angle for takeoffs, while in the retracted position the planing bottom fitted snugly to the hull and gave the whole a good streamline form.

Of all-metal construction, the Blackburn B-20 was powered by two Rolls-Royce Vultures of 1,720 hp. The hull was built throughout of aluminum-alloy, following normal stressed-skin construction, with transverse frames and longitudinal stringers, to which the skin was riveted. The tranverse frames were built up with plate webs and angle flanges of rolled or drawn section riveted to the webs. Bulkheads were built up from plate with extruded stiffeners.

The deck and side stringers of the portion of the hull forward of the break, and all the tail stringers, were continuous, the frames being slotted to receive them. Stringers were shallow bulb angle extrusions. Floor stringers of the portion forward of the break were intercostal and were attached to the frames by angle lugs on the web and diamond plates on the flanges. Skin covering of the hull and pontoon was flush riveted externally, and all joints were made so as to give a smooth finish.

Pontoon structure was similar to that of the hull, the deck and side stringers being continous and of the same section as used in the hull. The bottom stringers were intercostal and were of the same depth as the frames. They were built up with plate webs and extruded angle flanges. While dimpling was used in the upper hull riveting, no dimpling of the skin of the pontoon was done, since the plates were thick enough to take the countersink necessary for the rivet heads.

The pontoon was sub-divided into five separate watertight compartments by plate bulkheads, each compartment being reached from a deck hatch. Fuel tanks were set in the midship compartment, and large detachable covers allowed removal of the tanks. Bilge connections were provided for each compartment.

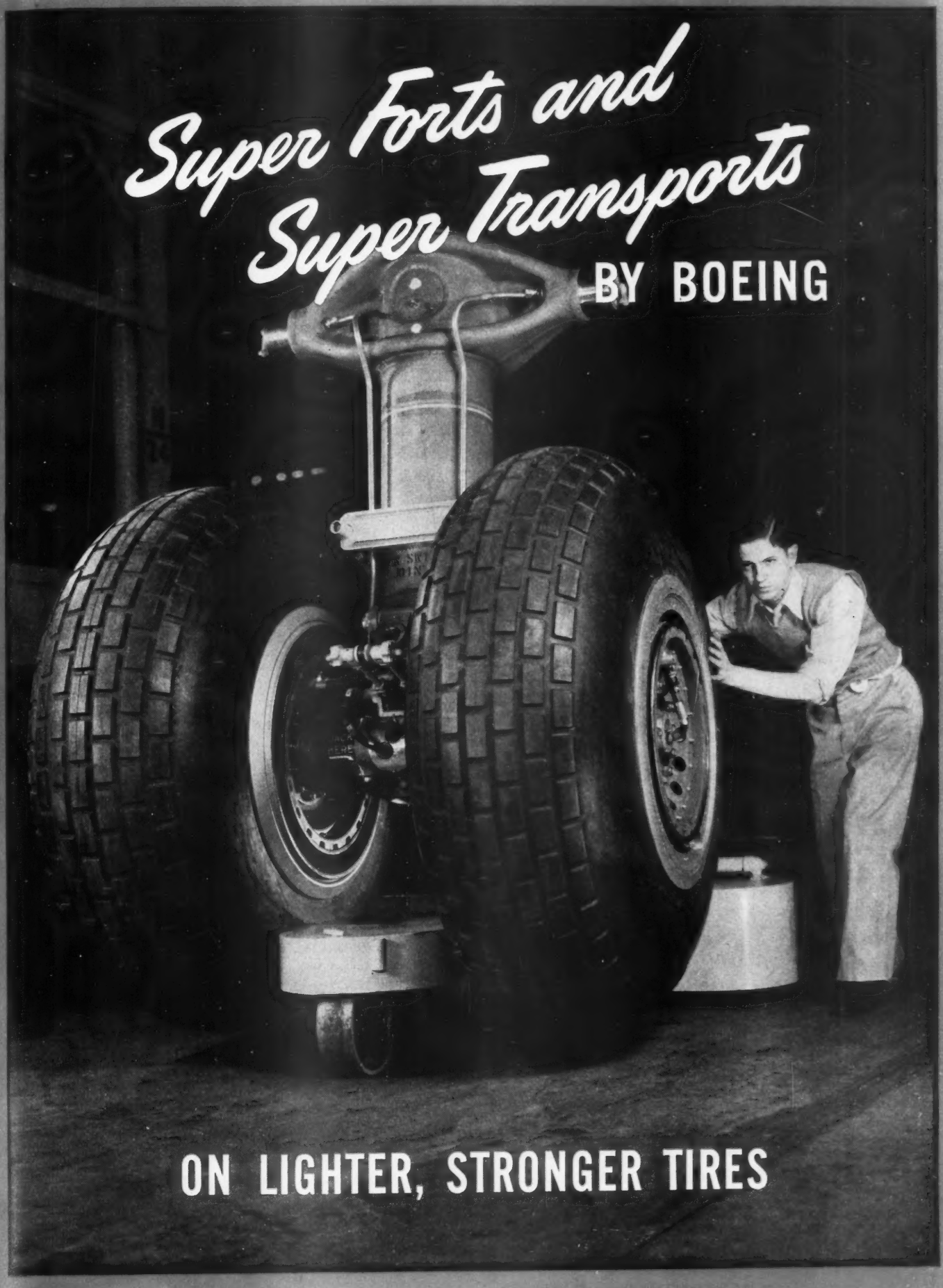
Wing tip floats were built similarly to the main hull. Each float was divided into four watertight compartments, each with a detachable cover for repair or cleaning accessibility. The floats were carried on hinge arms of box girder section built up from alloy, with stainless steel fittings.

Wings were built on three spars. In

(*Turn to page* 243)

Specifications and Data

Span (wing floats retracted)	82 ft.
Length	69 ft. 8 in.
Height (on beaching gear, hull extended)	25 ft. 2 in.
Wing area	1,066 sq. ft.
Chord (at root)	17 ft. 6 in.
Aspect ratio	6.3
Wing loading	32.8 lb./sq. ft.
Power loading	10.2 lb./hp.
Fuel capacity	976 gal.
Gross weight	35,000 lb.
Top speed (without armament)	322 mph.
Top speed (with armament)	306 mph.
Range (with armament)	1,500 mi.
Seating	Four
Power	2 R-R Vultures at 1,720 hp. ea.
Propellers	3-blade DH Hydromatic, 186 in. dia.



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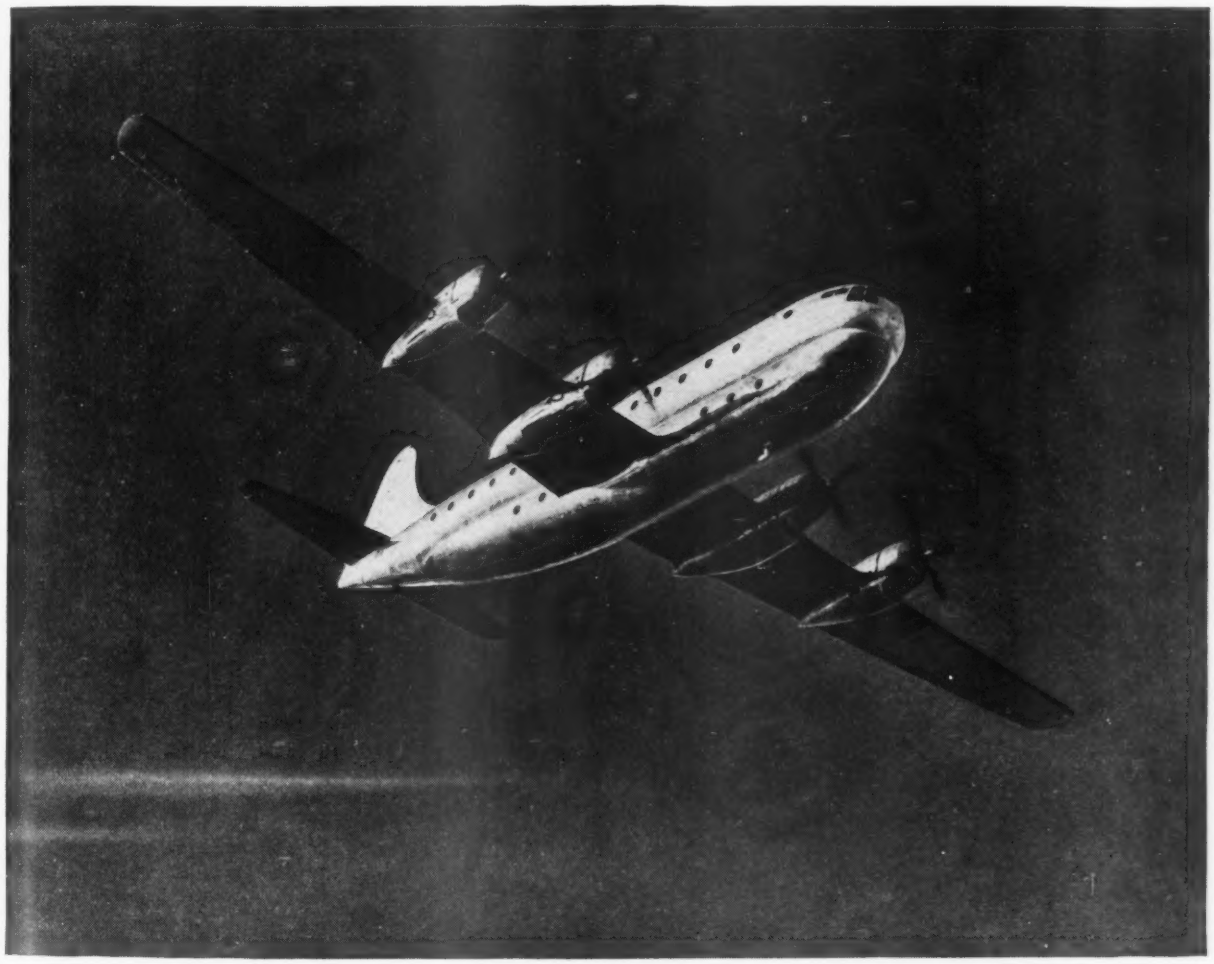

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BEATING THE FIRE HAZARD*

By **DIXON SPEAS,** *Assistant to Vice-President, Engineering, and*
MARVIN WHITLOCK, *Chief Aircraft Engineer, American Airlines*

Here are basic principles needing universal understanding to promote safety in aircraft operation—safety which must start with initial design and continue through modification and operation.

WHILE THE VULNERABILITY of aircraft and aircraft materials to fire is one of the most universally recognized considerations in the design, modification, and operation of airplanes, it is often one of the least appreciated.

Since aircraft fires can occur under a broad range of conditions and spread so fast, a thorough understanding of the principles of both fire protection and extinguishing are essential so that the potential hazards may be avoided.

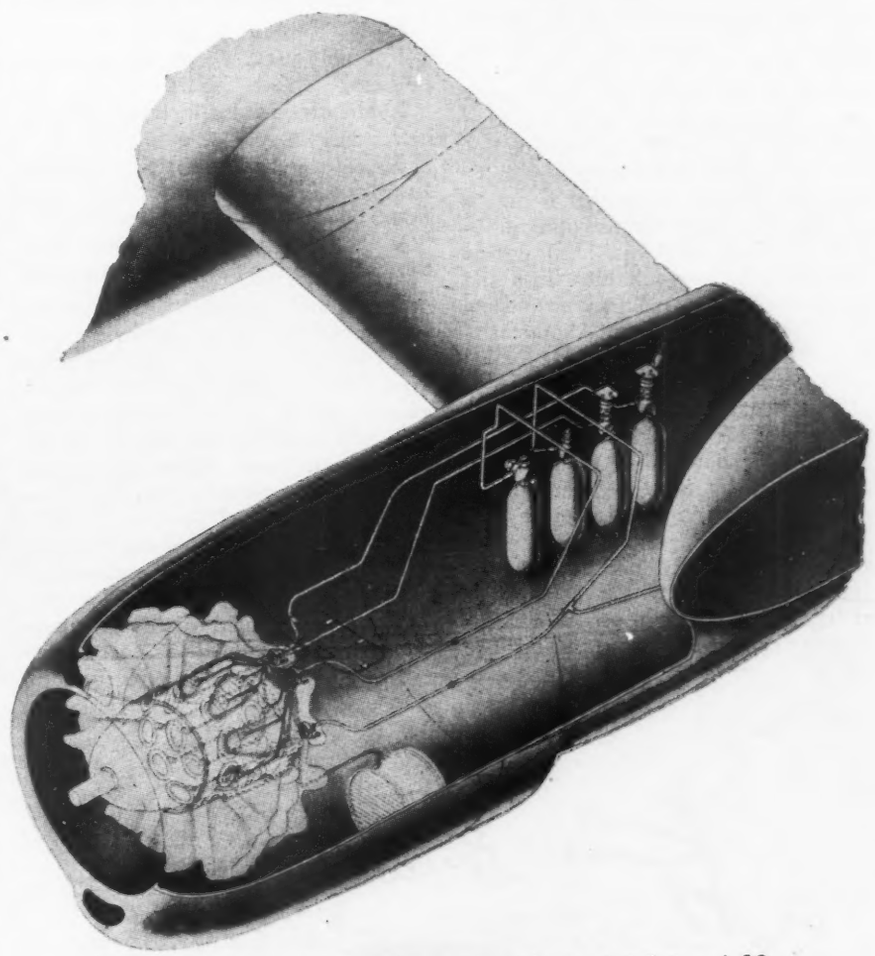
Burning may be defined as fast oxidation. Contrary to widespread belief, however, no combustible material ever burns as a liquid or solid. Instead, it is the material's volatile ingredients in the form of inflammable vapors which actually unite with oxygen. Close examination of a blazing puddle of oil, for example, will reveal that the liquid itself is not afire, but that the vapors from the surface have reached their ignition temperature and are burning. Heat is usually required to cause these vapors to be emitted in sufficient concentrations, and additional heat is always required to bring their temperatures up to the ignition point. It is this heat that is known as the source of ignition.

There are two pertinent temperature characteristics of materials which are indications of their ability to burn: (a) The flashpoint, which is the temperature of the material at which volatile vapors will momentarily flash if ignited by a flame; and (b) the ignition temperature, which is the temperature of the material at which the vapors will continue to burn when ignited by the flame.

These two temperatures are generally consistent for most materials and easily determined by standard procedures. It will be noted that the temperatures are by definition that of the material and not of the vapors.

The term combustible is usually used to define a material which will ignite in its normal state and continue to burn after the ignition source is removed, and the most important combustibles in aircraft can be classified either as liquids or solids.

Liquids: This classification includes gasoline, alcohol (de-icing), lubricating oil, and hydraulic fluid. All are volatile fluids and ignition of their vapors is a complicated function of the chemical composition of the fluid, the concentration of their vapors in the air, temperature and duration of the ignition source and, to some degree, the ionization condition of the mixture. None of these variables is mathematically determinate and therefore all available data are conservative inter-



Phantom view of nacelle fire-fighting system, showing installation of CO_2 bottles, also lines leading forward to engine to give complete coverage.

* Based on material from the authors' forthcoming book, *Airline Engineering*, to be published by the McGraw-Hill Book Co.

TABLE I—Approximate Characteristics of Liquids

Material	Flash Point (Deg. F.)	Ignition Temp. (Deg. F.)	Explosive Range (Percent by Vol.)
Gasoline	40–50	60–70	1.4–6.0*
Alcohol	55–65	70–80	
Lubricating oil	375–550	426–620	
Hydraulic fluid (Mineral oil)	235–290	255–330	

* 4.9-21.0% by weight (approx.)

pretations of tests conducted under a wide variety of methods and conditions.

Vaporization of a combustible must precede ignition and the vapor concentrations in the air must lie between certain limits before ignition will occur. In the case of most aircraft fluids these limits are quite broad, and they are of interest only insofar as practical problems are concerned. The initial boiling point as well as the vapor pressure of the liquid determines the ease of formation of this air-vapor mixture, and the flash point gives a rough measure of the temperature required to sustain combustion.

Efforts have been made to render the vapor in aircraft fuel tanks noncombustible as is done in some industrial installations. This is accomplished by introducing an inert gas in the air space, or by decreasing the rate of vapor formation by pressurization, or by use of fuel having low vapor pressure. These methods have not been successful because of the likelihood of converting what is normally a mixture too rich to burn to one that is highly combustible. There are also other problems involved, such as hard engine starting with low volatility fuels and the possibility of tank rupture when using pressure. Pertinent characteristics of the common combustible liquids are shown in Table I.

These data represent an average of the type of each liquid currently being used. It is noted that gasoline and alcohol are by far the most volatile of these liquids. For this reason, and due to the high ignition temperature, these materials are not likely to be ignited by contact with a hot surface if in *open air* because proper concentrations cannot be obtained. They are more likely to be ignited by a spark or open flame under similar conditions due to the higher temperature of the ignition source. Oils are less volatile and, although they have a higher ignition temperature, are likely to be ignited by a hot surface even in open air. Hence oil is an equal if not greater fire hazard than gasoline, particularly in respect to the power plant. Oil fumes are difficult to ignite by spark and, generally speaking, are less apt to explode than gasoline vapors, due to the lower heat content of the liquid.

Solids: This classification includes fabrics, woods, electrical insulation, thermal insulation, soundproofing material, and plastics.

The majority of fabrics used in aircraft may be divided into the following groups:

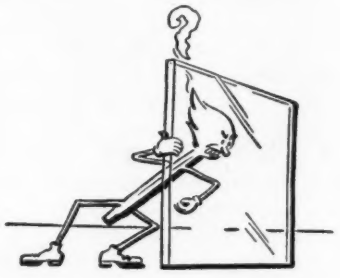
1. Wool—used in rugs, blankets, upholstery.
2. Mohair—used in kickpads, drapes, etc.
3. Cotton—used in sheeting, protective boots, lining, seat padding, curtains, and control surface covering.
4. Rayon—usually mixed with cotton and used for drapes, curtains, etc.

Wool and mohair (Angora-goat hair) are fibers of animal origin and when subjected to decomposition from heat, liberate non-flammable nitrogeneous gases. Therefore, these materials will smoulder but are not likely to burst into flame. Rayon and cotton, fibers of vegetable origin and composed mostly of cellulose, are readily combustive and have a strong tendency to smoulder, even with a minimum of oxygen.

Wood is commonly used for minor non-structural installations, for passenger compartment partitions and floorboards, and when used for those purposes, is not likely to be ignited except by direct contact with flame. However, it is a treacherous fire hazard because it can change its state, without noticeable burning, to one which has a much lower ignition temperature. A piece of wood subjected to heat will char and the charred wood will, under certain conditions, ignite at an ignition temperature of less than 225 deg. F. as compared to 750 deg. F. for the natural wood.

The majority of aircraft electrical equipment operates at low voltage and the electrical insulation requirements for wiring are met by use of a hard spun fabric or glass braid woven over a fabric tape. The fabric is treated with a fire-resistant flexible coating similar in appearance to a lacquer or shellac. The combination is not fireproof, but it is "fire resistant," having an Army-Navy Specification maximum limit on flame travel of 3 in. per min. It must withstand 240 deg. F. without igniting or charring.

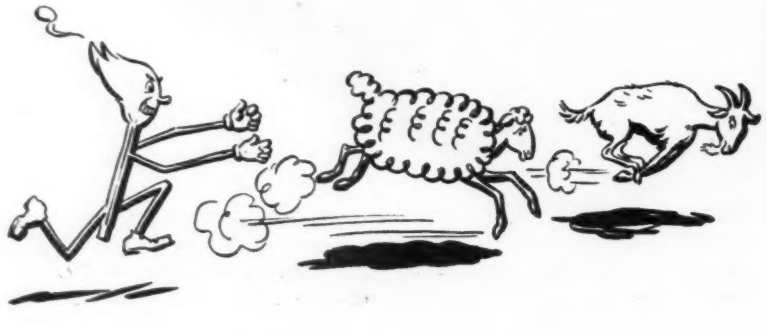
The thermal insulating and soundproofing materials in current use are composed of either imitation fibers,

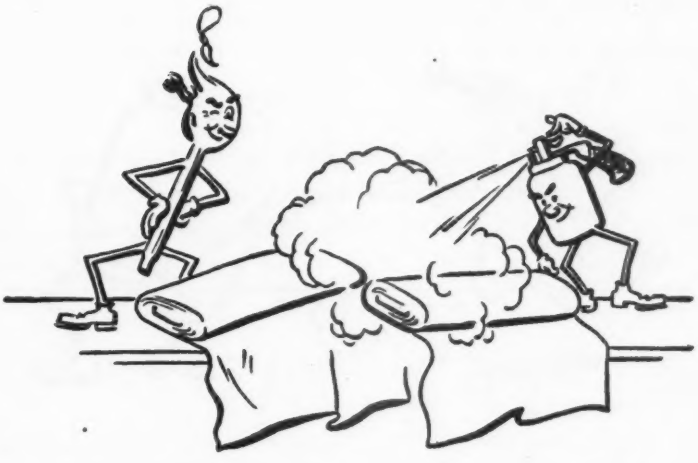


such as spun glass, cellulose fibers as in cotton, Kapok (fibers from a pod growing on a ceiba tree), or paper. The spun glass material is incombustible, but the other materials are readily flammable. Some wool is used for these purposes and as previously explained is naturally fire resistant.

Innumerable synthetic materials which might be called plastics are being introduced into aircraft use. The most common trade names of the nontransparent plastics are Bakelite, Micarta, and Formica, none of which support combustion. The most common transparent materials are known as Plastacele (cellulose acetate), Plexiglas (acrylic acid), Lucite (methaerylic acid), and Pyrolin (non-explosive nitrocellulose and camphor). Plastacele, Plexiglas, and Lucite burn very slowly when a lighted match is held to them.

The majority of the fabric materials mentioned above respond to what is known as a "flameproofing" process. This treatment does not render the





materials non-combustible, fireproof, or fully resistant to charring and decomposition, but it will make the material resistant to ignition by a relatively small flame or source of heat and will prevent continuous flaming after removal of the source of ignition. In this process, chemicals are deposited in or on the fabric by spraying or immersion; and the chemicals, as selected, provide the flameproofing in one or more of the following ways:

1. In the presence of heat, non-flammable gases are given off by the chemicals, diluting the flammable gases from the decomposing material. This serves to check oxidation, accordingly curbing the risk of continuous flaming.

2. By producing a glaze over the fiber surface, the chemicals cut the supply of oxygen.

3. The fabric is protected by being loaded with a non-combustible substance.

Method 1 is most commonly employed and should be repeated periodically on all non-woolen fabrics in the airplane.

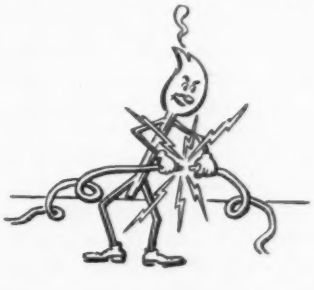
Source of Ignition

The term "ignition" usually implies an open flame in contact with the combustible material. However, in the true sense, ignition is the means by which some part of the combustible is raised to its ignition temperature. The sources of this means for raising the temperature of materials in aircraft may be conveniently classified as follows:

1. *Hot surface:* Hot metal surfaces, when in open air, present very little hazard relative to liquids, for tests have indicated very little likelihood of even lubricating oil and gasoline igniting under such conditions. However, hot surfaces in combination with confined volumes of air and vapors or in surface contact with a combustible material present a most dangerous source of ignition. Also re-ignition is likely to occur from such sources because the rate of cooling after extinguishment is usually slow due to the enclosure inhibiting convection of the heat.

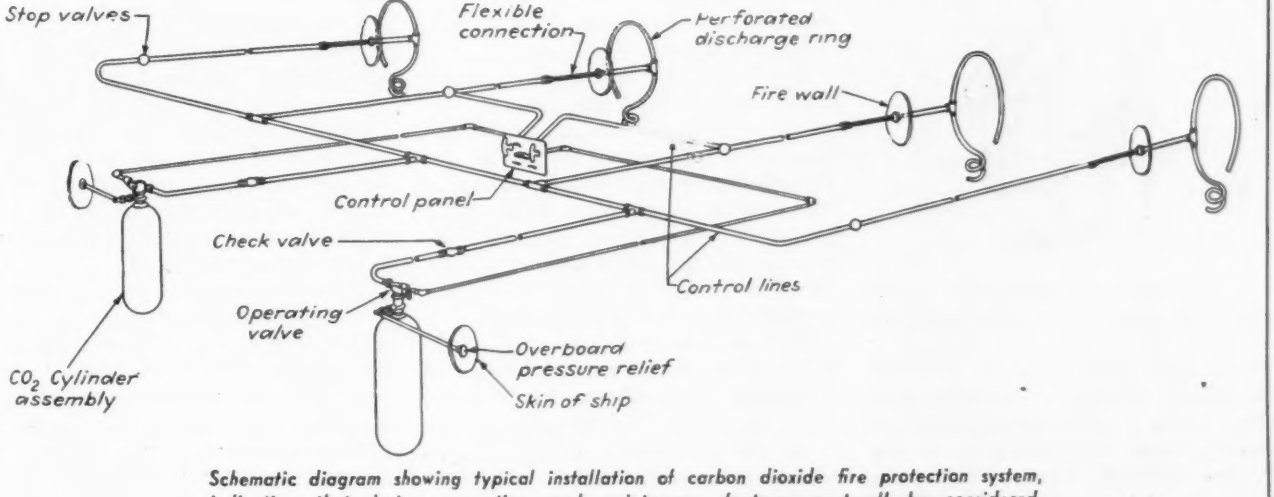
Most likely source of such ignition is the engine exhaust system, which is usually enclosed to some degree. It reaches a temperature of 1,000-1,200 deg. F. in flight and may reach 1,300-1,500 deg. F. immediately after stopping of the engine. Overheated wiring and electrical units are another source of "hot surface" ignition. Friction heat, from such sources as bearings which are deficient in lubrication, can easily reach temperatures within the hazard range.

2. *Electrical Discharges:* Such discharges in the form of sparks or arcs may emanate from a number of sources, such as motors, relays, switches, electrical shorts, static discharges, lightning strikes, and ferrous metal contacts. As a source of ignition, sparks and arcs are similar, and they have to exist for sufficient time to raise the temperature of a portion of the combustible to its ignition point. This time element is recognizable in the case of solids, whereas in the case of gases the time is so short that the ignition



may be considered as being instantaneous on the occurrence of a single spark.

The terms "lightning" and "static discharge" (synonymous in principle) are generally applied to a visible arc trailing to or from the airplane. This arc is apt to occur as the plane nears an oppositely charged cloud; as it passes between two oppositely charged



Schematic diagram showing typical installation of carbon dioxide fire protection system, indicating that design, operation, and maintenance features must all be considered.

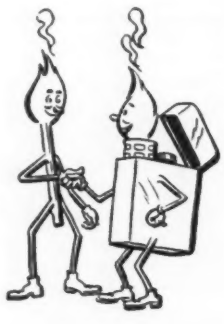
clouds; or if it is in the direct path of a discharge between the ground and a cloud.

The charge on the airplane can be induced by friction with particles in the air, such as dust, rain, and snow; or the airplane may be acting as a conductor of charges during one of the above-mentioned conditions. In either case, the charges being of one polarity resist each other and seek the perimeter, causing the outer shell of an integrally bonded metal airplane to be the only portion that is electrically charged.

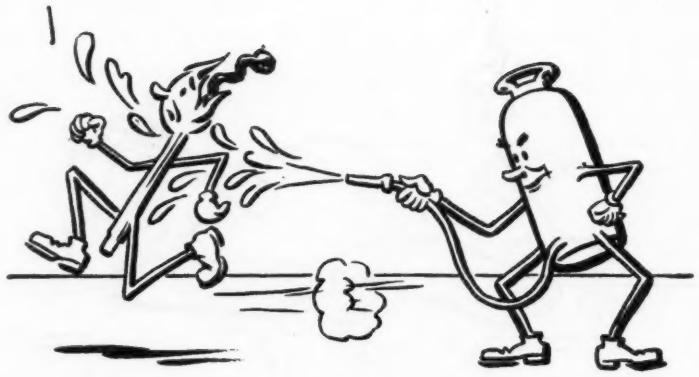
Therefore, damage is usually confined to a small hole burned in the skin at the point of release of the charge. A slight hazard is introduced if combustible materials are present at that point, but usually the slipstream is sufficient to cool the material below the ignition temperature.

The more dangerous electrical discharge is the type frequently occurring between a gasoline hose nozle and a fuel tank while fueling. Friction from the fuel passing through the nozzle introduces a static charge and, if opposite to the nearby structure, a spark is likely to occur. For that reason, it is necessary for the hose to be a conductor and for the ship and fueling unit to be connected electrically and in a safe place before fueling begins.

3. *Open Flames:* These are a very versatile source of ignition and are capable of igniting all the combustibles found in aircraft, over a wide range of conditions. Cracks and other failures of the exhaust system are a prolific source of flames. The exhaust tailpipe emits flame under certain engine operating conditions. Flame exists in the gasoline type heating system and also is present due to the use of matches and cigarette lighters by the crew and passengers.



4. *Spontaneous Combustion* (autogeneous ignition): The heat required to raise the temperature of a combustible to its ignition temperature need not necessarily be furnished by an external source such as a hot surface, flame, or spark. It may be produced by the heat of slow oxidation. The laws of thermochemistry state that every chemical reaction is accompanied by a definite change in heat content and that most reactions evolve heat. The combination of oxygen with oil produces heat of high calorific value and, if confined, may be sufficient to raise the temperature to the ignition point of any surrounding combustibles.



Fire Detection

One of the prime requisites of successful fire extinguishment with a limited amount of extinguishing agent is early application of the agent. This obviously concerns the relation between the amount of heat to be absorbed to that of the effective specific heat of the amount of extinguishing agent available or the ability of the extinguishing agent to reduce the oxygen content below where it will support combustion.

While there are few thoroughly satisfactory fire detectors currently available for aircraft, there are a number of principles being explored for use as aircraft fire detecting devices.

The two main classifications of detectors would be: (a) The *unit detector,* a mechanism capable of detecting a flame at or near its particular location; and (b) the *continuous detector,* a form of conduit or wire capable of detecting a flame anywhere along its length.

Of the unit detector class, the three most common principles employed are represented in the *flame, metal expansion,* and *thermocouple* types.

The flame type detector is a spring loaded switch held open by two or more combustible threads, and the unit is so constructed as to protect the threads from mechanical damage without shielding them from flame. With proper selection of thread material, this type is relatively large and must be located in the path of the flame (as determined by smoke flow tests).

The metal expansion detector works on the principle of direct or differential expansion of metals due to increases of temperature. Conventional types incorporate a convex metal disk (fixed on the periphery) which "oil cans" under a temperature change to make contact at the center. Other indicators of this type use bimetallic strips which deflect under temperature changes. Most designs are insensitive to small flames and require envelopment in flame for rapid indication. However, they are compact and reasonably immune from mechanical damage.

The thermocouple detector consists of a hot- and cold-junction thermocouple unit connected in series. The hot junction is exposed to the flame and the cold junction is shielded from the flame but exposed to the ambient temperature. This type operates on a rate-of-temperature-rise principle and the current produced is used to operate a relay for purposes of indication. Its unit provides a rapid rate of indication and is reasonably compact and immune to mechanical damage.

Of the continuous class of detectors, the most common are the *fusible alloy* and *ionization* types. The fusible alloy types are usually in the form of a wire or conduit which incorporates parallel electrical conductors together with a fusible alloy of an electrically conductive material. The assembly is so constructed that the fusible alloy in its normal state is separated from at least one of the conductors, but when heated will flow and contact both conductors, thereby making electrical contact.

The temperature setting of the indicator is determined by selecting an alloy having a melting point at the desired temperature and by carefully controlling the alloy. This type has the advantage of being able to indicate a fire anywhere along its length, but it is inclined to have low indication rate since heat must penetrate the materials before fusing takes place.

The ionization indicator consists of two parallel electrical conductors, usually a wire and a metal surface, with an electrical field imposed between the two. The air separating the two conductors is normally not a conductor. However, in the presence of flame, the tendency is for the neutral gas molecules to split into positive and negative

(*Turn to page* 249)

Shall the principle that air transportation is a special industry be adhered to by Congress, or shall the gains of years of struggle be swept away in an effort to solve problems of older modes of transportation? Here is —

THE CASE AGAINST REGULATORY INTEGRATION

By JOHN H. FREDERICK,

Professor of Transportation & Industry, University of Texas

THERE IS LITTLE DOUBT that all modes of transportation are in for another "sweeping investigation" by a joint House and Senate Committee with the avowed purpose of bringing about a "coordinated government policy."

The ground work for such an investigation was laid last summer in both House and Senate, and if it follows the path of those in the past, the first move toward what has been termed a "consistent public policy, fair to all competing agencies of transportation, to the using and investing public, and to labor," will be to place the regulation of air transport under the same federal body as are other carriers. This means the Interstate Commerce Commission, either as presently organized or revised, or some sort of a new commission.

There is no doubt that the proponents of a single regulatory body for all forms of transportation have some good arguments on their side. They maintain that, on grounds of logic alone, it is hard to make out a case for a regulating authority for air transportation separate from other forms, particularly if we are to continue a national policy of promoting and fostering adequate transportation furnished by private corporations at rates regulated by public authority.

They also point to the fact that separate regulating agencies are no longer used for other forms of transportation —the motor carrier, the water carrier engaged in inland or coastwise transportation, the pipe line, and the freight forwarder. All have been brought within the jurisdiction of one federal body, the Interstate Commerce Commission.

Proponents of a single regulatory agency for all forms of transportation refuse to admit there are technical characteristics of air transportation which make it more difficult to regulate than railroads or any other forms of regulated transport. They do grant, of course, that the ICC would have to adapt and equip itself to provide intelligent and efficient regulation should it be charged with this new power over air transportation. But they feel that this would be relatively easy to carry out.

Railroads and other ground carriers see "integration," the new name for air-surface-carrier combinations, complicated by the regulatory situation as long as airline regulation is in the hands of a separate agency, as it has been since 1938. They also maintain that air transportation has progressed beyond the stage in which the solicitude and promotional aid of a separate, specialized regulatory body is needed.

The type of "regulation" which nearly all advocates of ICC or other centralized control of air carriers have in mind is "economic" in nature. Also, many of them still contend that the railroads, in particular, are subject to "unregulated competition" because of airline activities.

This latter assertion has been proven incorrect time after time, but it still crops up. It is an example of the statements so often made concerning air transportation by those who know little or nothing about it—statements which are often misleading, or which, without basis in fact, are false.

The truth of the matter is that the air carriers *are* regulated. They believe in regulation. They asked for regulation. They sought economic regulation patterned after the provisions of Parts I and II of the Interstate Commerce Act; and in the Civil Aeronautics Act of 1938, Congress imposed upon the air carriers just such a pattern of regulation. It is held by many that were the railroads and motor carriers regulated as thoroughly as are the airlines they would hardly know what to do. Neither the ground carriers nor any other industry in the United States is regulated in such minute detail as are the airlines.

The reason the air carriers sought regulation, beginning in 1934 and continuing steadily until the passage of the Civil Aeronautics Act of 1938, was that they realized the history of railroad transportation had demonstrated that the absence of regulation can lead to evils from which not only the public but those in the industry itself suffer. The Civil Aeronautics Act of 1938 was, therefore, a comprehensive statute covering all phases of civil aeronautics. The ICC itself even admits (in its 52nd Annual Report) that "the Civil Aeronautics Act provides for air carriers a system of regulation which is, if anything, more comprehensive than that which has been provided for the railroads."

When, therefore, it is proposed that there be "uniform regulation, similar in character and scope, for all modes of transportation" a statement has been made which the railroads themselves would be the first to brand as absurd when the full import of such a recommendation is appreciated. In short, the complaint that, in relation to other modes of transport, railroads are discriminated against in the matter of regulation is utterly without justification, so far as the air carriers are concerned.

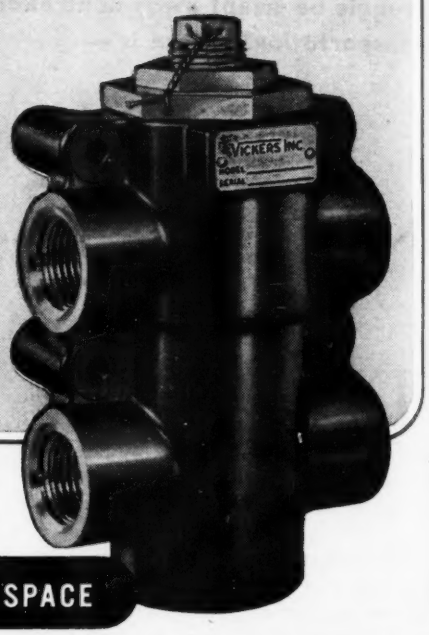
When the railroads were fighting the canal companies and stage lines for business they were not subject to regulation. No one said anything about

(*Turn to page* 242)

ONLY 35 psi PRESSURE INCREASE
Over Volume Range From 1 to 16 gpm

Valve Model No. AA-11248 (AN 6200-8AB)
Normal AN Rating . . . 6 gpm
Max. Recommended Cap . . . 9 gpm

VICKERS AIRCRAFT HYDRAULIC
Balanced Piston RELIEF VALVE



SAVES WEIGHT and SPACE

The exceptionally accurate pressure regulation of the Vickers Aircraft Relief Valve shown here over a volume range of 2⅔ times its rating is demonstrated by the test results illustrated at the right.

This valve was set for 1000 psi at its rated capacity of 6 gpm; the actual pressure was then determined at flow rates from 1 to 16 gpm. At a flow rate of 1 gpm the pressure was 995 psi and at 16 gpm the pressure was only 1030 psi . . . an increase of only 35 psi.

This ability to handle a volume much in excess of its rated capacity means that a smaller size Vickers Relief Valve can be used with a resultant saving in weight and space. These valves are available in four sizes having rated capacities of 1.2, 3.5, 6.0 (size illustrated) and 16 gpm. Without parts change, all valves have operating pressure ranges from 300 to 2100 psi; adjustment is easy. By "venting" they can be used to unload the pump in certain hydraulic circuits. These valves conform to AN specifications; they comply with AN-6200 envelope and with Winterization requirements of Army Air Forces.

VICKERS *Incorporated*
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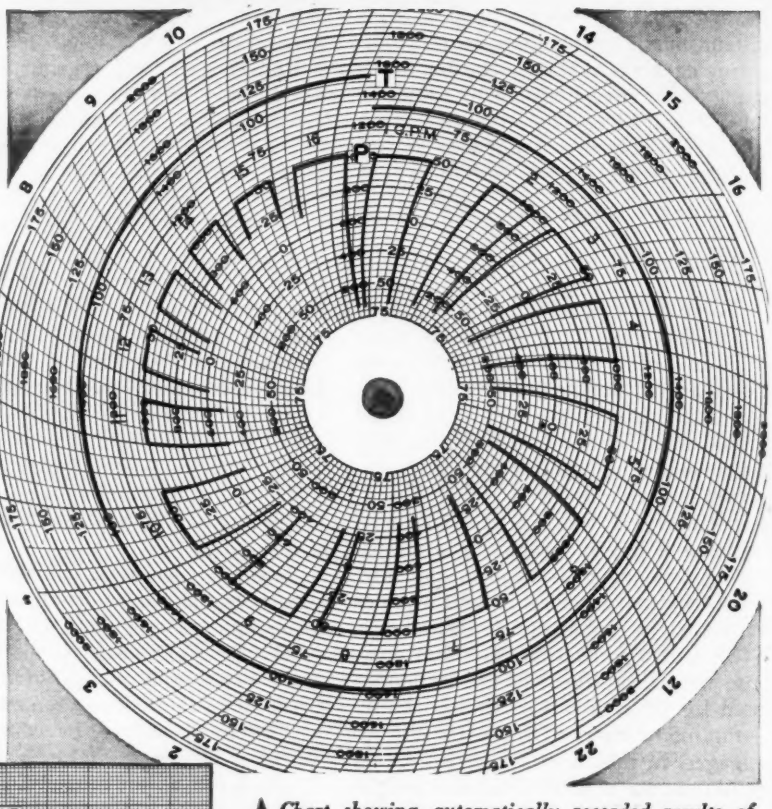
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921



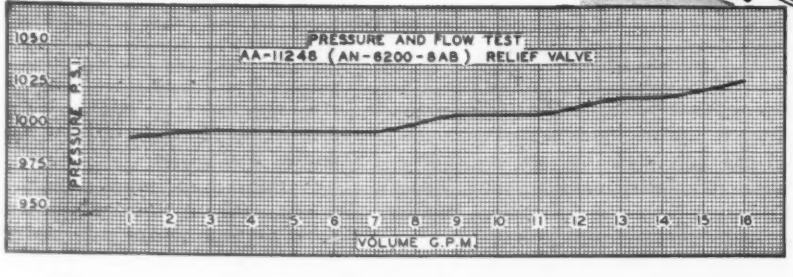
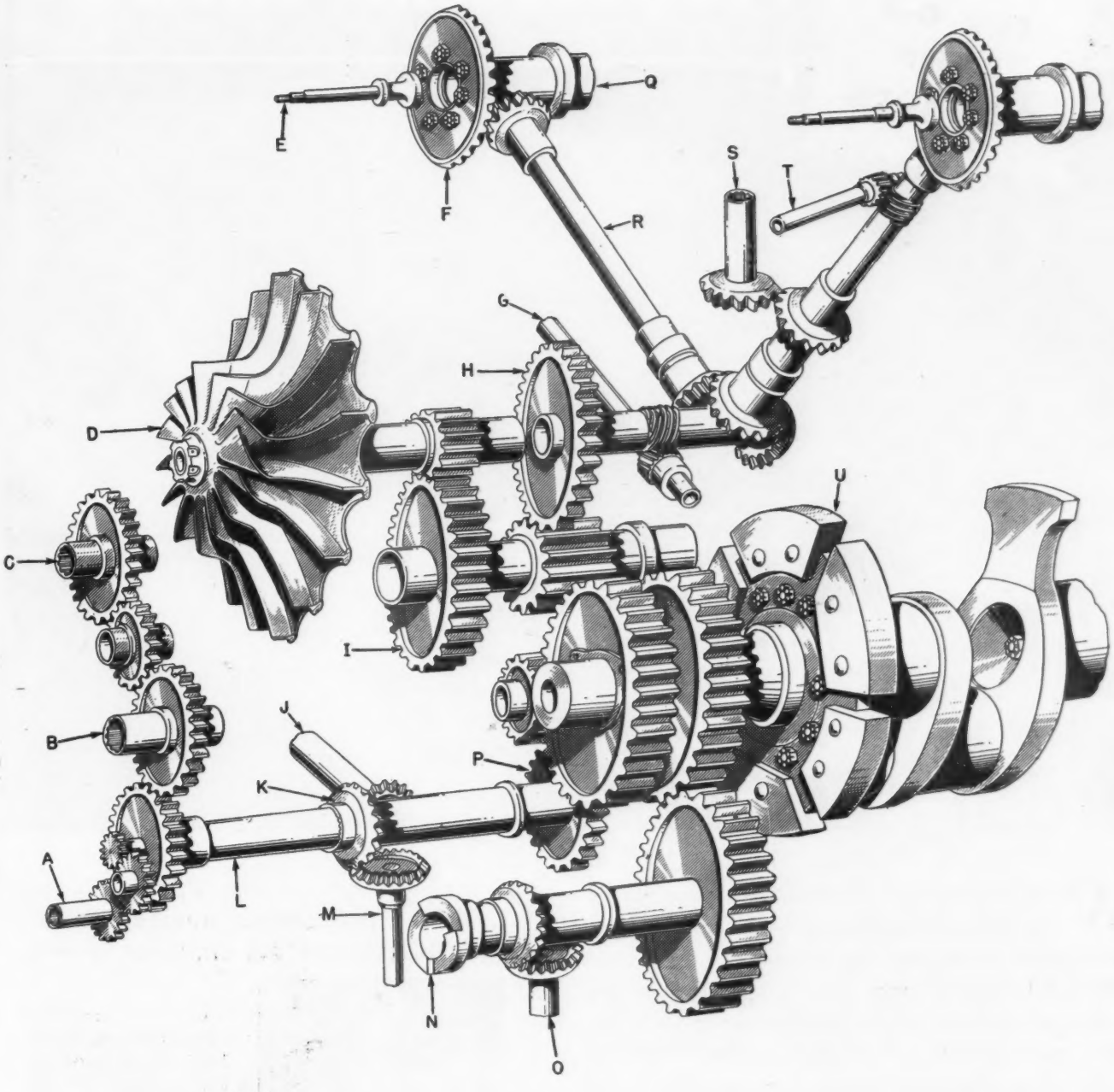


Chart showing automatically recorded results of pressure and flow test made upon Vickers Relief Valve having setting of 1000 psi at its normal rated capacity of 6 gpm. Time is in minutes. Code: "T" is temperature and "P" is pressure.

Data recorded on chart above plotted on rectangular coordinates to permit more easy evaluation. Note that pressure varies only from 995 to 1030 psi when flow rate is increased from 1 to 16 gpm.

AVIATION'S SKETCHBOOK OF DESIGN DETAIL



Gear train of Allison engine, showing fuel pump drive (A); generator drive (B); rear vacuum pump drive (C); supercharger impeller (D); distributor drive (E); camshaft gear (F); electric tachometer drive (G); accessory housing camshaft drive gear (H); supercharger impeller drive gear (I); side vacuum pump drive (J); generator and pump drive shaft coolant pump drive gear (K); generator and pump rear drive shaft (L); coolant pump drive (M); starter shaft jaw (N); oil pump drive (O); generator and pump drive shaft gear (P); left camshaft (Q); camshaft upper drive shaft (R); magneto drive (S); mechanical tachometer drive (T); and dynamic balancer (U).

ANOTHER FIRST FOR G-E LAMP RESEARCH

G-E "CIRCLINE" FLUORESCENT LAMPS

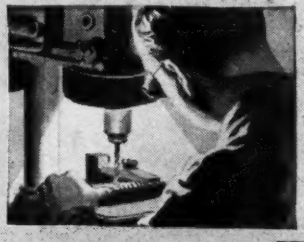
WITH development of G-E CIRCLINE Lamps, new opportunities open up for use of cool, efficient, glare-free fluorescent lighting in industry.

First G-E CIRCLINE Lamp to be completed (available early next year) has an outside diameter of 12 inches and a tube diameter of 1¼ inches. Two additional lamps are planned, with outside diameters of 8½ and 16 inches. The 12-inch lamp will operate at 32 watts and 84-86 volts. Its light output is estimated at 1600 lumens and brightness at 2040 footlamberts. Tests indicate a rated life corresponding to the standard 40-watt fluorescent lamp.

LAMPS

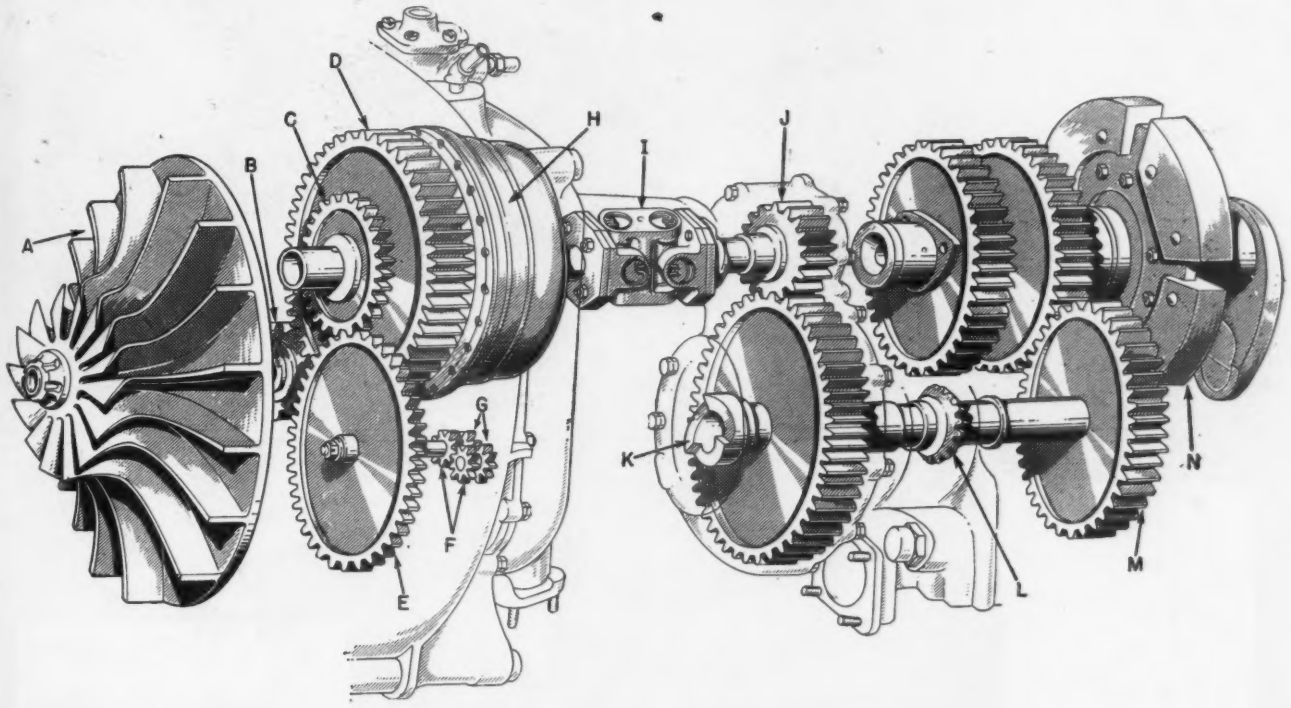
GENERAL ELECTRIC

TYPICAL INDUSTRIAL APPLICATIONS SUGGESTED FOR G-E CIRCLINE LAMPS

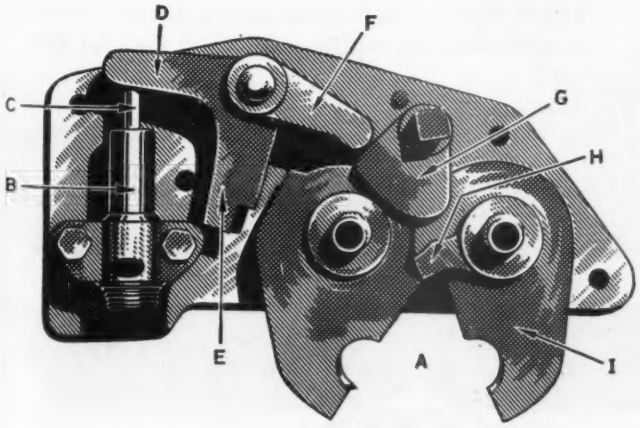


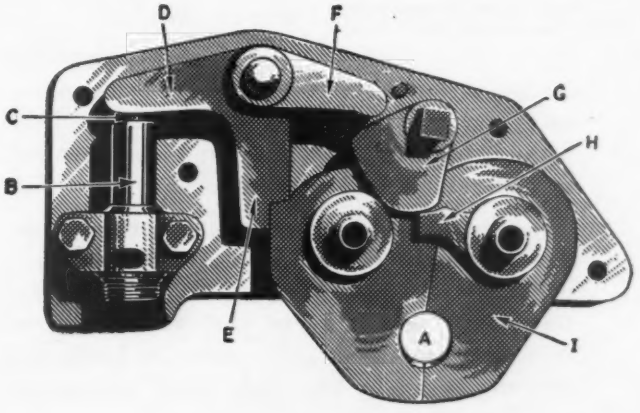
CIRCLINE Lamp furnishes diffused, even illumination on working surface in this idea for machine tool lighting.

Many difficult inspection jobs will be easier with the use of G-E CIRCLINE Lamp to "surround" with light the object inspected.

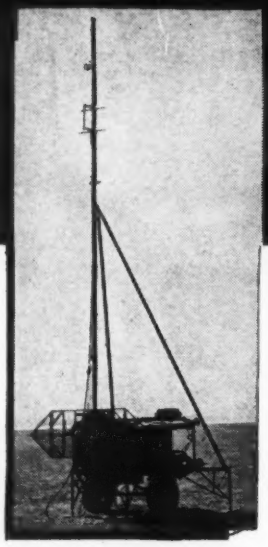


Allison V-1710 auxiliary supercharger gear train, showing impeller (A); impeller shaft (B); coupling shaft oil drive gear (C); impeller drive shaft (D) which is driven through splines with rear half of hydraulic couplings; oil pump drive shaft (E); scavenge oil pump gears (F); pressure oil pump gears (G); hydraulic coupling (H); universal joint (I); power takeoff pinion (J); starter shaft jaw (K); starter shaft pump drive gear (L); starter shaft gear (M); and dynamic balancer (N).

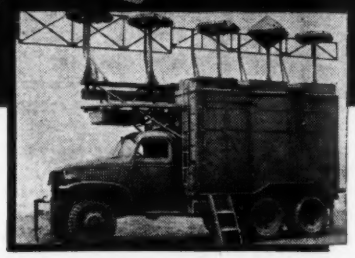




Bomb release mechanism of Jap Betty bomber, shown in closed position (above) and open (left). Bomb shackle is fitted into hole (A). Releasing sequence is as follows: Moving up through housing (B), plunger (C), actuates arm (D). This moves (E) to unlock half of release at same time arm (F) is moved down actuating cam (G), tripping release mechanism through cam (H).



FTR Glide Path Transmitter (Air-Transportable Army Type)



FTR Localizer Transmitter-Truck Mounted (Army Type)

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Here's the instrument landing system, adopted as *standard* by the Army and Navy, that provides the sure and accurate pathway to earth...developed and manufactured by Federal . . . operated the world over.

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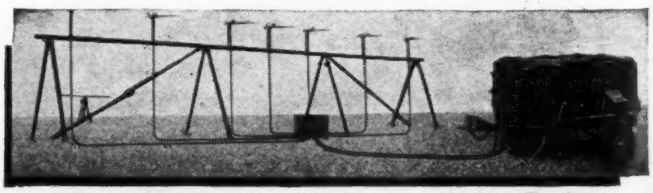
Countless perfect instrument landings by skilled American airmen prove the reliability of Federal's Instrument Landing equipment . . . the result of a decade of intensive research . . . an important contribution to the war . . . with even wider service promised for the coming age of the air.

For the finest in radio aids to aerial navigation and communications equipment . . . see Federal first.



FTR Localizer Transmitter (Air-Transportable Army Type)

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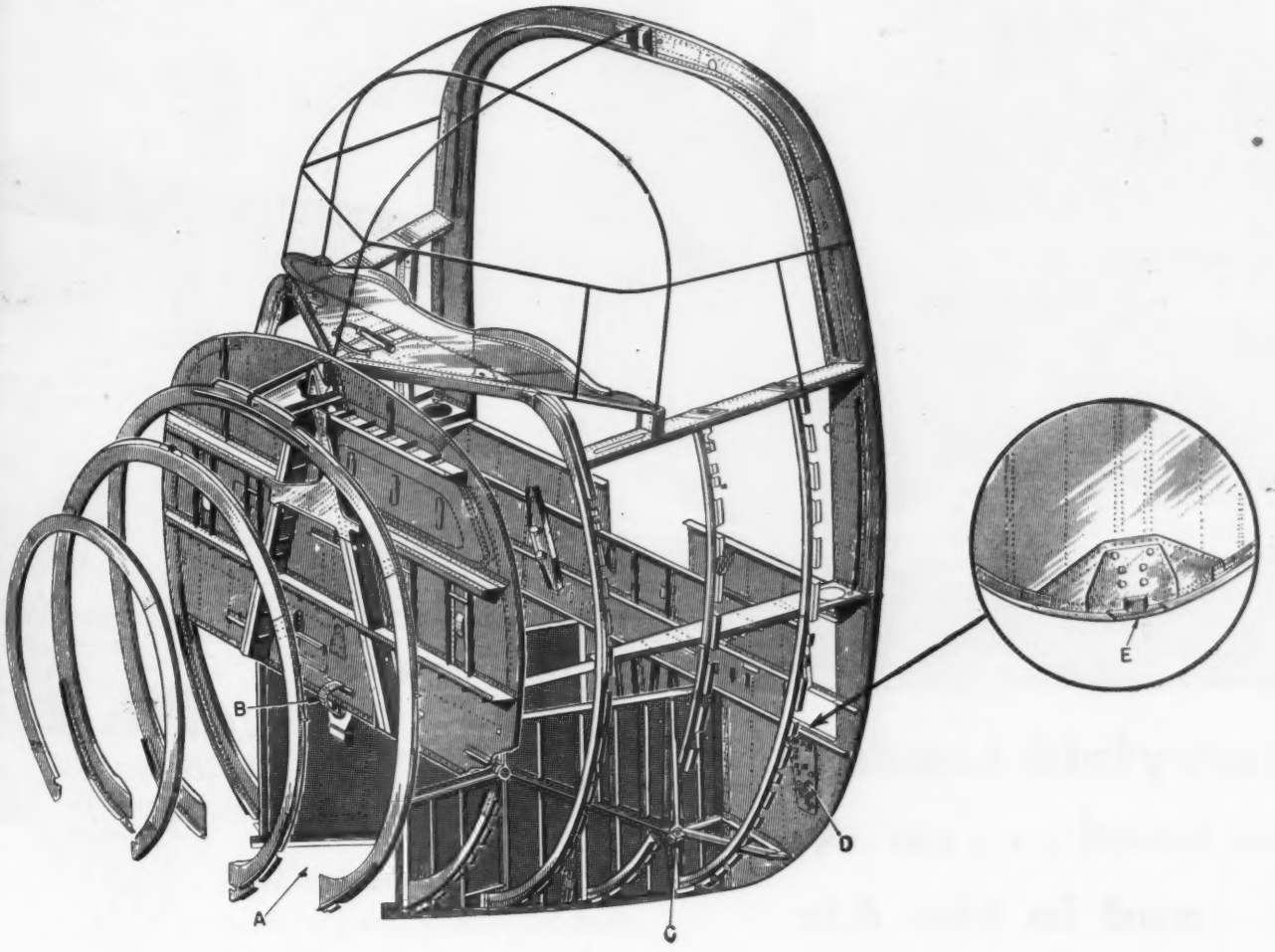
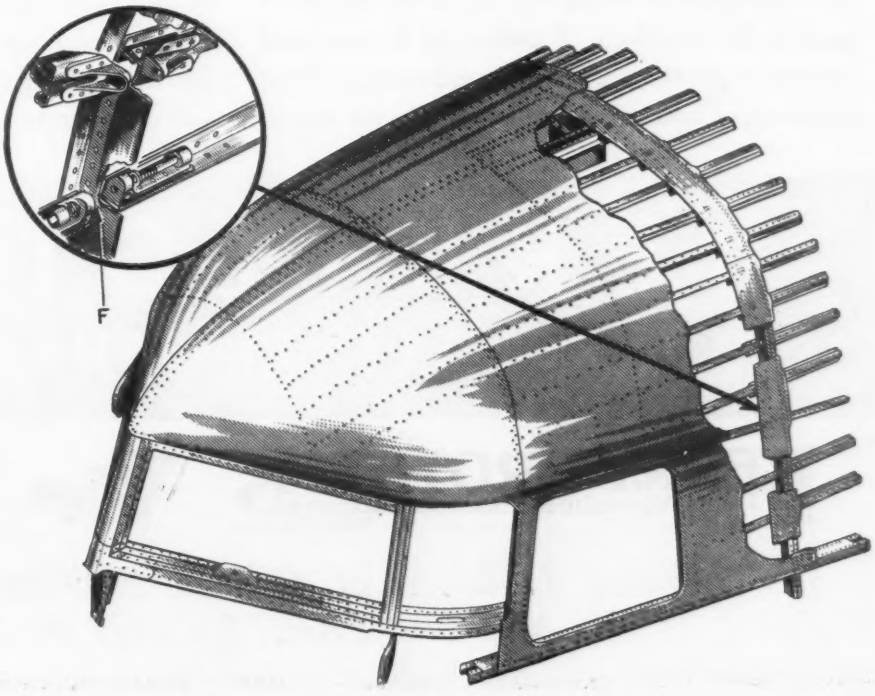


Above: Demountable nose section of Douglas C-54, with skin and longerons removed to show cutout in frames for nose wheel well (A) and nose wheel flight brake (B) employed to prevent wheel spinning in flight. Longitudinal beam and fittings for nose wheel assembly are at (C), line disconnect manifold is at (D), and in circled sketch alongside is close-up view (E) of forward fuselage jack fitting. Right: Details of demountable nose section, with circled sketch (F) showing typical attachment to main fuselage section.



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SIMPLIFIED DESIGN SAVES TOOLS AND TIME

How STRIKINGLY the use of tools may be minimized and production time cut is typified by Convair's design simplification of a bomber's ammunition box support bracket.

Fig. 1 shows the conventional engineering design which necessitated numerous operations and tools (as specified in tabulation on following page) for the fabrication of the unit. Fig. 2 shows simplified features of the new bracket design, which affords considerable reduction in the number of operations and tools required (also listed in tabulation).

Redesign of another small airplane part also effected appreciable savings in production time and costs. Fig. 3 (following page) shows the original makeup of the part, which required approximately 20 tools in the course of 19 operations for fabrication. And in Fig. 4, the unit is seen as redesigned by Convair engineers so that it could be blanked, pierced, hydropressed, bent, and drilled from a single sheet of dural —5 operations requiring but 8 tools. The new part is stated to withstand greater stresses than the originally designed unit.

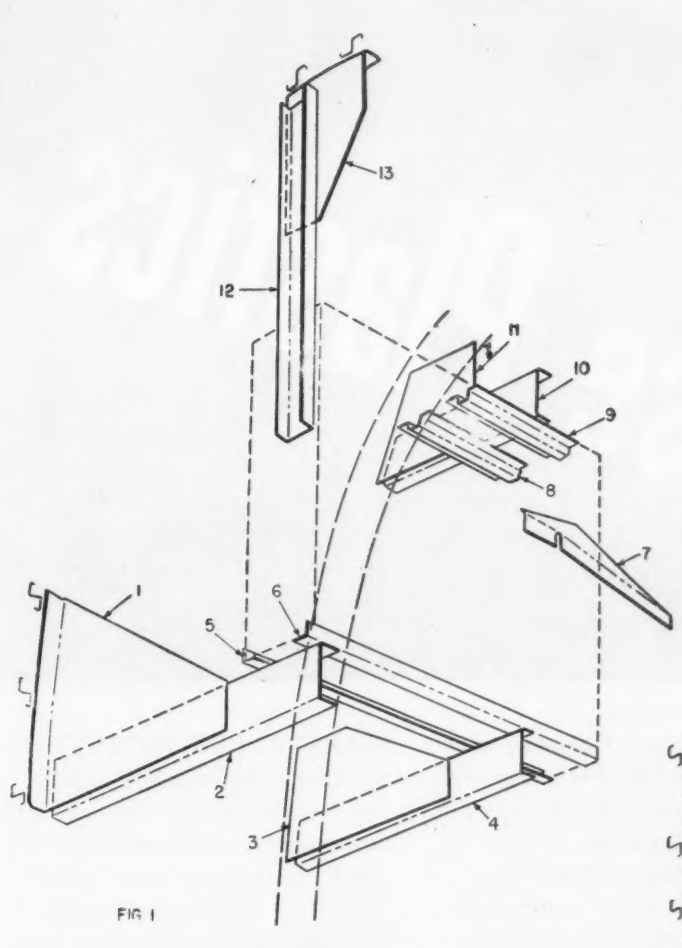


FIG. 1

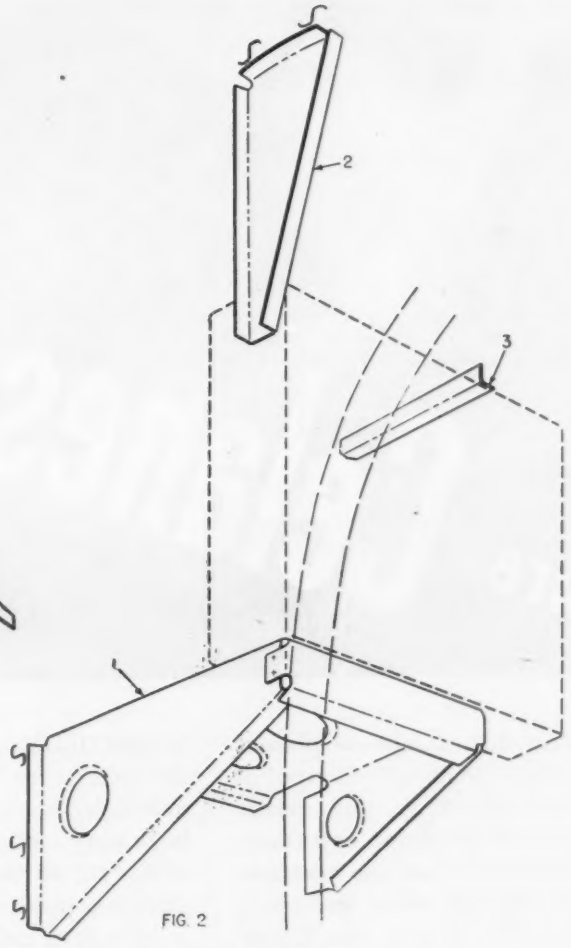


FIG. 2

Fabrication of old design ammunition box support bracket (Fig. 1) required large number of operations and tools—greatly reduced in simplified version of bracket shown in Fig. 2. Numerals refer to detail numbers in comparative tabulation (following page).

25 out of 32 plastics items on 1942 Oldsmobiles

THE WIDE USE of Celanese plastics in the 1942 Oldsmobile is proof of the broad functional and design possibilities of these cellulosic thermoplastics. From the injection-molded steering wheel and glove compartment door to the Hydra-Matic control box the 25 separate applications add up to plastics versatility that is of prime importance to the product designer today.

VERSATILITY put Celanese plastics high on the list of war-essential materials. Development work in the laboratory—intensified to keep up with ever stricter military specifications—resulted in new plastics formulations and improved characteristics for standard types. These wartime developments promise a wider range of usefulness for Celanese plastics than ever before.

PLANNING NEW PRODUCTS? Remember that Celanese plastics are No. 1 materials for creative design and sound craftsmanship. Consult the Celanese technical staff for up-to-date information about new formulations and improved characteristics. Celanese Plastics Corporation, *a division of Celanese Corporation of America*, 180 Madison Avenue, New York 16, N. Y. *Reg. U. S. Pat. Off.

OLD SUPPORT BRACKET (FIG. 1) REQUIRED—

Detail No.	Operation	Tools
1	Blank and pierce	Combination die
1	Pierce attach. holes	Pierce template
1	Pilot pierce holes	Master template
1	Form complete	Form block and tooling template
2	Cut to size	Production sample
1-2	Subassembly	Assembly fixture
3	Square shear to size	Mark template
3	Multipunch holes	Multipunch bar and tooling template
4	Cut to size	Production sample
1-2-3-4	Subassembly	Assembly fixture
5	Cut to size	Production samples
5	Multipunch holes	Multipunch bar and tooling templates
6	Cut to size	Production sample
6	Multipunch holes	Multipunch bar and tooling template
1 to 6	Subassembly	Assembly fixture
7	Blank and pierce	Combination die
7	Pierce attach. holes	Pierce template
7	Pilot pierce holes	Master template
7	Form on bend brake	Pierce template
8	Cut to size	Production sample
8	Multipunch	Multipunch bar and tooling template
9	Cut to size	Production sample
9	Multipunch	Multipunch bar and tooling template
10	Cut to size	Production sample
10	Multipunch holes	Multipunch bar and tooling layout
11	Square shear to size	Mark template
11	Multipunch holes	Multipunch bar and tooling layout
1 to 11	Subassembly	Two assembly fixtures
12	Cut to size	Production sample
12	Multipunch holes	Multipunch bar and tooling template
13	Blank and pierce	Combination die
13	Pilot pierce holes	Pierce template
13	Pilot pierce holes	Master template
13	Form on hydropress	Form block and tooling layout
1 to 13	Assembly	Assembly fixture

. . . BUT SIMPLIFIED UNIT (FIG. 2) REQUIRED ONLY—

Detail No.	Operation	Tools
1	Blank and pierce	Combination die
1	Pilot pierce holes and slots	Pierce template and master template
1	Form beads and bends	Form block and tooling template
1	Bend on brake (4 bends)	Pierce template
1	Drill and rivet	Drill jig
2	Blank and pierce	Combination die
2	Pilot pierce attach. holes	Pierce template and master template
2	Form on hydropress	Form block and tooling template
3	Cut to size	Production sample
3	Multipunch holes	Multipunch bar and tooling template

FIG. 3

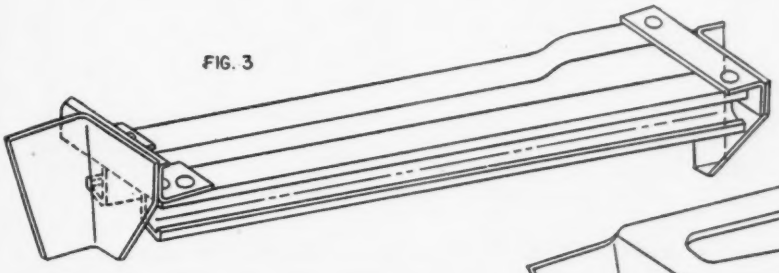
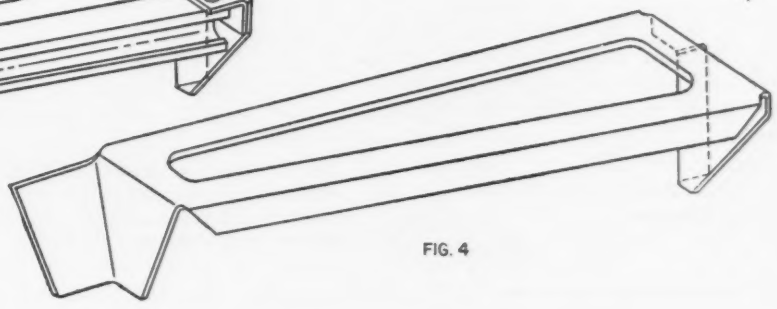


FIG. 4



Original design of small aircraft part (Fig. 3) required about 20 tools and 19 operations for fabrication, whereas redesigned unit (Fig. 4) required but 8 tools and 5 operations.

PILOT SAFETY PLUS MAINTENANCE EASE FEATURED IN F4U CORSAIR REFINEMENTS

HAZARD OF CARBON MONOXIDE accumulation resulted when engine exhaust on the F4U Corsair was carried by the slipstream along the bottom and sides of the fuselage streamline back to the tail, where the tail wheel door, arresting-hook cutout, and other openings, permitted seepage of gas into the fuselage and then forward to the cockpit. Particularly critical places of seepage were at points where cable passed through bulkheads.

A simple and gas-tight cable seal was devised consisting of Neoprene and felt pads, as shown in Fig. 1 (following page). Located at bulkheads, in combination with slotted phenolic fairleads, the pads are cut through from the long edge to the middle to permit initial installation after the cable has been rigged and to facilitate seal replacement. The felt pads are installed after being saturated with raw soybean oil and thoroughly squeezed to remove excess lubricant.

Pad mounting holes are spaced $\frac{1}{8}$ in. greater than fairlead and bulkhead mounting holes and the cable hole center line is $\frac{1}{8}$ in. below the mounting hole centerline, so that when the pad is installed, compression forces act on each side of the cut.

The seal tends to hug the cable, and when the latter moves, the cut edges act as lips, are displaced in the direction of cable travel, and maintain close wiping contact, effectively sealing against carbon monoxide. The installation adds but a negligible friction load to the cable.

Flap Step. A novel flap step (Fig. 2) on the F4U Corsair provides easy and safe mounting for access to the cockpit in contrast to the former mounting procedure, which gave the cumbersomely equipped pilot an unsteady and awkward position as he first kneeled on the inboard center section flap to reach the wing walkway preparatory to placing his foot on the hinged level-footing step in the sloping gull wing.

With the new installation the flap may be lowered, from the ground, to an almost vertical position by pressing in the hinged step, located in the right side of the fuselage, to actuate a cable attached to the wing flap selector valve. If insufficient pressure is available in the accumulator to accomplish hydraulic lowering to full-down, the flap may be pushed down manually.

With the inboard flap in this position, the flap step—a kick-in type hinged near the trailing edge—offers an easily reached, steady footing for

stepping directly onto the hinged level-footing in the sloping gull wing, and it also obviates need for the rough surface walkway, which produced considerable drag at high speeds.

Taper Pin. For attachment of stabilizer to fuselage on the F4U, a taper pin was used in conjunction with split bushings passing through aligned holes of the male and female fitting combination, the bushings having internal taper corresponding to that of the pin. Tightening of a nut on the small-diameter end of the taper pin drew the large-diameter end down to spread the split bushing, thus giving a firm fit with surrounding bushings in fittings.

When difficulty was experienced in dislodging the pin from this very secure connection, it was reworked (Fig. 3) to facilitate emergency removal. Large-diameter end of pin was tapped to receive an Allen set screw, to which it was staked in three places to prevent turning, and by tightening a nut threaded on the set screw, removal of pin from split bushing was rapidly effected. To obviate necessity for such rework, new pins in production for this installation were threaded at the large-diameter end.

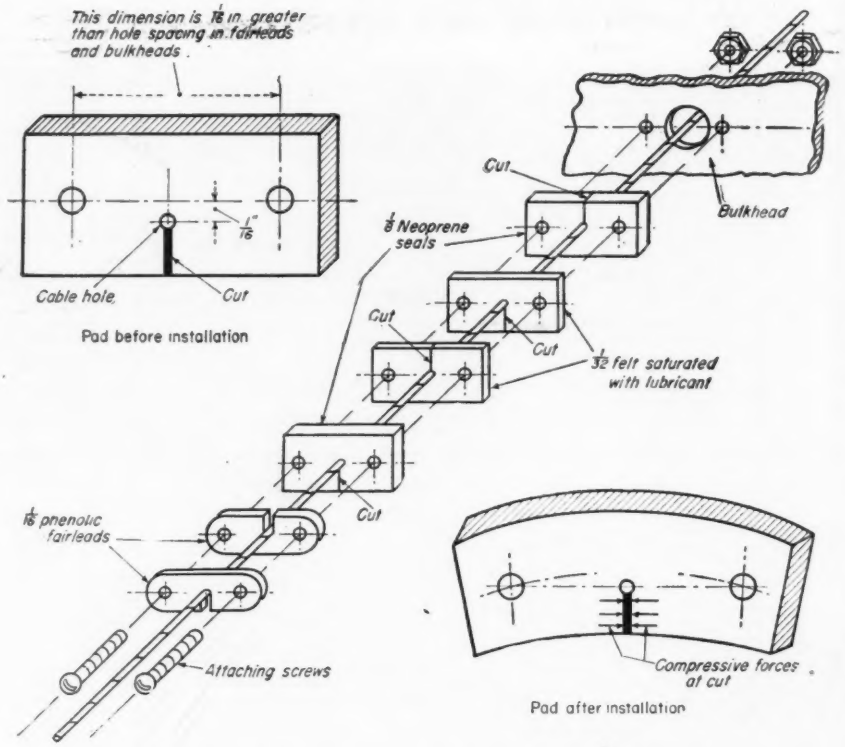


Fig. 1. Simple installation of Neoprene and soybean-oil-saturated felt pads, seen here in exploded relation, is used as cable seal on F4U Corsair to prevent seepage of carbon monoxide back into cockpit, which had resulted from engine exhaust being carried by slipstream to fuselage openings in tail.

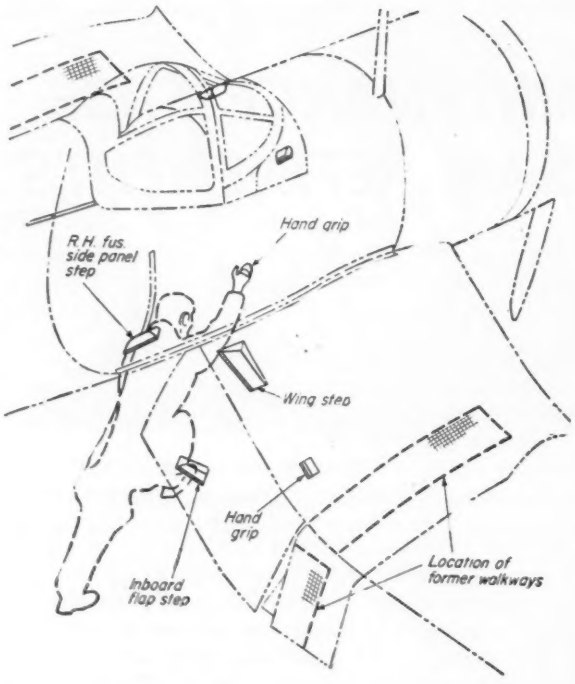


Fig. 2. Phantom view shows how new flap step on F4U facilitates access to cockpit, eliminating need for drag-creating walkway. Flap is lowered from ground, hydraulically, by pressure on step in fuselage side.

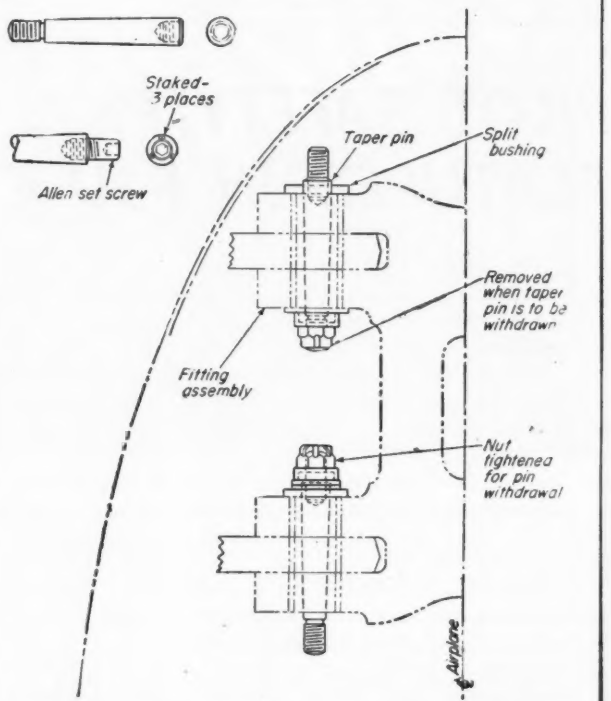
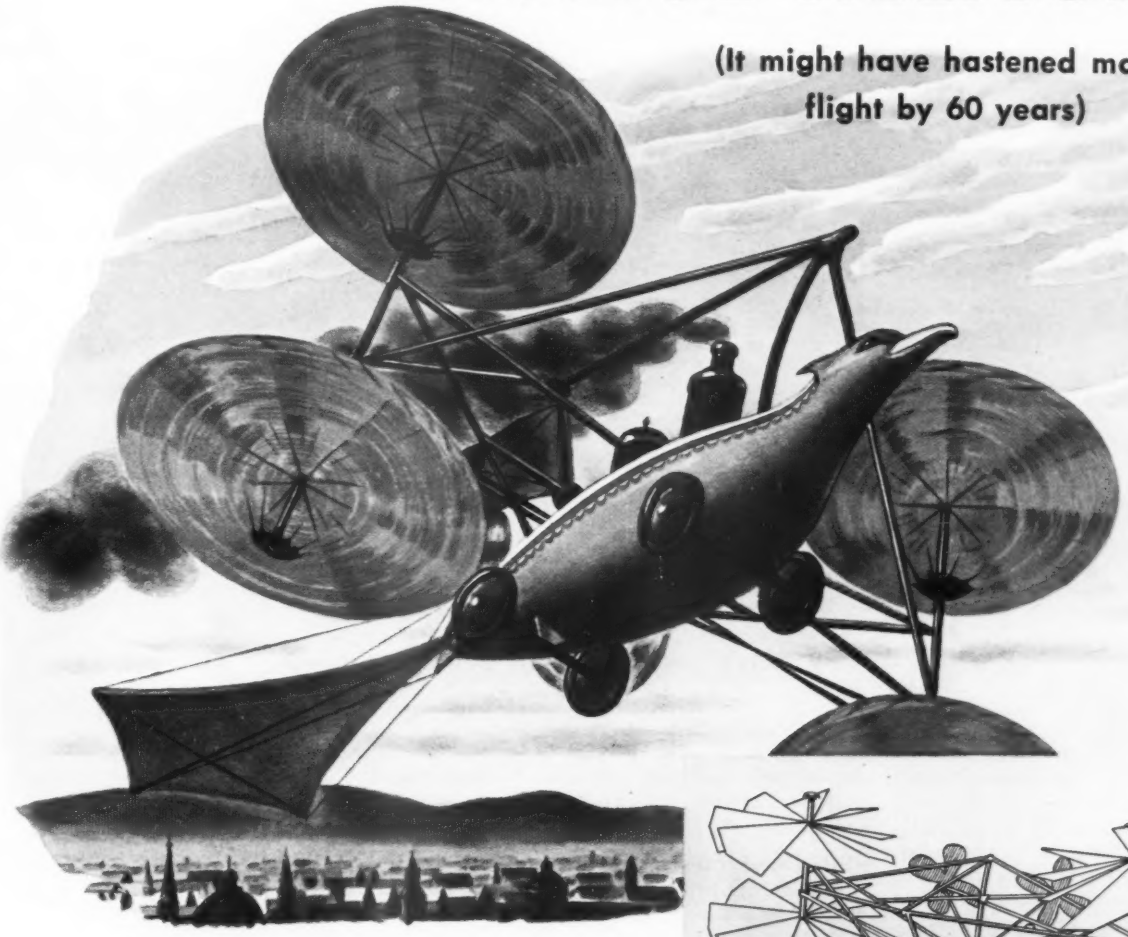
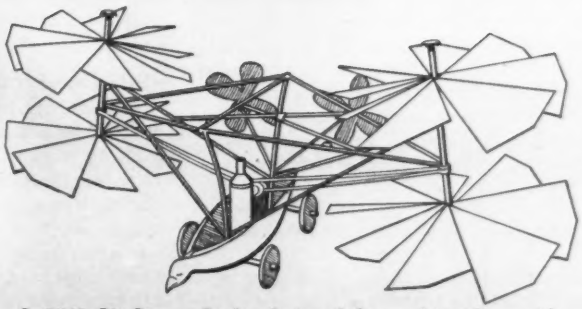


Fig. 3. Reworked taper pins shown here in stabilizer attachment fitting on F4U, are easily removed by tightening nut down on Allen set screw which is threaded and staked into large-diameter pin end.

SIR GEORGE CAYLEY'S STRANGE HELICOPTER

(It might have hastened man's flight by 60 years)





In 1840, Sir George Cayley designed the machine above with two steam-driven propellers and double-tiered, rotating wings (set at an angle of incidence) on each side of the fuselage. Modern authorities believe that, if constructed, Cayley's design might actually have flown.

COMPARE today's ocean-spanning plane with Cayley's helicopter. Compare your sky trip today with the Wright brothers' flight of 284 yards at Kitty Hawk.

Man's air triumphs are triumphs in a peculiar battle — a battle of *Lift* versus *Drag*. A fight between *Lift* caused by air passing around a wing and *Drag* created by resistance of air to the plane's passage.

Northrop has been in the foreground of the battle for many years. There's the multicellular, internally-braced wing, Northrop pioneered in 1929. The stressed-skin wing built entirely of metal was a Northrop achievement of 1930. Today's high-altitude flying was pioneered by experiments in a Northrop "Gamma" of 1934. Double split dive flaps and retractable ailerons were 1935-1942 contributions.

Further to increase Lift and reduce Drag is a continuing project at Northrop. We have set our sights at still more efficient propulsion, and at designs like the Northrop Flying Wing, in which nearly all elements will contribute to Lift. Northrop Aircraft, Inc., Northrop Field, Hawthorne, California.

Creators of the ***Black Widow***

P-61 Night Fighter and the ***Flying Wing***

NORTHROP

Pan-American World Airways
204-Passenger Clipper*

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They can't come too big for "Pittsburgh" Aircraft Finishes

TYPICAL of the aviation industry's tremendous plans that will materialize in the future is Pan American's proposed new giant of the air. To be built by Consolidated - Vultee, this enormous six-engined Clipper is designed to accommodate 204 passengers and is expected to cruise at 310-342 m.p.h., operating above the weather at 30,000 feet.

Supplying the protective coatings for flying ships like this is a major task that calls for leadership in paint making—leadership that springs from intensive research, wide experience gained during the war period, and *quality control* in the manufacture of aircraft finishes.

That's why America's builders of future aircraft can look to "Pittsburgh" with complete confidence, no matter how big, how difficult the job—no matter how elaborate the specifications. Our unmatched facilities, extensive knowledge and expert skills are at your command. *The sky's the limit!*

"Pittsburgh" Aircraft Finishes are flying with the huge Mars, Constellation and Superfortress—the big "Cats"—as well as with the Hellcat and the Thunderbolt. There is no greater evidence of the stamina, long life and protective qualities of these famous "fighting finishes" than their unsurpassed performance under conditions in which such aircraft must operate. There is no better proof that aircraft manufacturers can *continue* to look to "Pittsburgh" for quality-controlled finishes with a PLUS over specifications!

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PITTSBURGH STANDS FOR QUALITY PAINT AND GLASS

*Wing span: 230 feet. Length: 182 feet. Upended on its wing it would outreach a 21-story building! Three of these 204-passenger Clippers at but 50% capacity would carry, yearly, 150,106 passengers between Honolulu and California — more than three times the largest number carried by sea and air combined in any year before Pearl Harbor.

SHEET NUMBER D-32
CLASSIFICATION ..... Materials
SUB CLASSIFICATION ..... Synthetic Compounds

Physical Properties Of Hycar Compounds

Tables give basic properties after immersion and exposure under varying conditions and for different periods.

Physical Properties

Compound No. and Base Material	Modulus at 300% Elongation—Psi.	Ultimate Tensile Strength—Psi.	Ultimate Elongation, %	Shore Hardness	Lupke Rebound % (Resilience)	% Compression Set ASTM—Method B	% Compression Set 70 hr. at 212 Deg. F.	Specific Gravity	Low Temperature Flexibility ASTM Test—Deg. F.
1239-HCR-133(OR-25)	325	1,400	775	43	49	25	58	1.15	—40
1275-HCR-6(OR-25)	2,200	2,290	305	65	37	5	27	1.27	—40
1239-HCR-163(OR-25)	1,725	2,000	350	60	41	8	27*	1.24	—50
1275-HCR-25(OR-25)	....	2,050	120	90	29	10	49	1.36	—10
1601-HCR-1(OR-15)	900	3,600	675	67	20	14	70	1.19	—15
1601-HCR-9(OR-15)	1,800	2,680	475	54	48	6	40	1.21	—40
1601-HCR-10(OR-25)	1,700	2,310	415	54	54	4	36	1.20	—65
1601-HCR-12(OR-25)	690	1,800	620	49	53	10	40	1.20	—65
1230-HCR-55(OR-15)	2,450	4,550	470	80	17	19	56	1.24	—20
1232-HCR-56(OR-25)	750	1,800	560	42	55	19	..	1.20	—70
1128-HCR-100(OR-15	1,900	2,200	365	56	45	18	69	1.22	—20
1628-HCR-16(OR-25)	1,875	2,250	355	56	55	14	64	1.22	—50
1101-HCR-46(OS-10)	1,625	1,800	340	58	42	13	45	1.22	—40

*70 hr. at 250 deg. F.

After Immersion 28 Days at Room Temperature

	Original	Normal Sulfuric Acid	Normal Caustic Soda	Kerosene	Turpentine	Ethylene Glycol	Butyl Alcohol	Carbon Tetrachloride	Distilled Water	Glycerine
1128-HCR-100(OR-15)										
Ultimate tensile....	2,200	2,040	2,130	2,450	2,210	2,100	1,880	1,130	1,860	2,350
Ultimate elongation	365	320	320	310	295	305	280	195	295	340
Shore hardness....	56	56	57	60	61	60	58	52	58	57
% Volume change.		5	2	—3	—1	1	2	25	3	1
1628-HCR-16(OR-25)										
Ultimate tensile....	2,250	2,140	2,100	2,240	1,850	2,500	1,950	810	1,915	2,175
Ultimate elongation	355	350	315	355	300	335	335	175	345	335
Shore hardness....	56	55	55	56	53	55	55	43	53	55
% Volume change.		5	1	—2	8	2	0	52	8	1

After 70 Hr. Immersion

	Origina	At 212 Deg. F. ASTM-SAE Oil Aniline Pt. 159 Deg. F.	At 212 Deg. F. Hydraulic Oil Aniline Pt. 189 Deg. F.	At 212 Deg. F. Paraffine Lub. Oil Aniline Pt. 240 Deg. F.	At Room Temp. 65 Octane Gasoline	At Room Temp. 40% Aromatic Gasoline	At Room Temp. Air Oven Aging 70 hr. at 212 Deg. F.
1239-HCR-133(OR-25)							
Ultimate tensile.....	1,400	1,530	1,530	2,100	850	450	1,010*
Ultimate elongation.....	775	610	630	590	540	360	235
Shore hardness.....	43	40	43	47	35	24	55
% Volume change.....	....	8	2	—8	10	46	....
1236-HCR-56(OR-25)							
Ultimate tensile.....	1,800	1,700	.....	.....	.....	750	1,700
Ultimate elongation.....	560	415	.....	.....	.....	310	305
Shore hardness.....	42	46	.....	.....	.....	32	50
% Volume change.....	....	1	.....	.....	.....	28	....
1601-HCR-12(OR-25)							
Ultimate tensile.....	1,800	1,950	2,100	2,550	1,700	950	2,250
Ultimate elongation.....	620	450	410	455	600	400	355
Shore hardness.....	49	51	60	66	47	35	61
% Volume change.....	....	1	—6	—12	1	24	....
1601-HCR-9(OR-15)							
Ultimate tensile.....	2,680	2,475	3,000	3,190	2,300	1,290	2,700
Ultimate elongation.....	475	315	335	340	465	275	300
Shore hardness.....	54	65	70	70	57	50	62
% Volume change.....	....	—7	—11	—11	—1	15	....
1275-HCR-6(OR-25)							
Ultimate tensile.....	2,290	2,200†	.....	1,300†	.....	.....	2,300
Ultimate elongation.....	305	240	.....	130	.....	.....	175
Shore hardness.....	65	63	.....	71	.....	.....	73
% Volume change.....	....	—14	.....	—2	.....	.....	....
1232-HCR-60(OR-25)							
Ultimate tensile.....	1,700	1,910	.....	.....	.....	1,100	1,775
Ultimate elongation.....	120	100	.....	.....	.....	90	85
Shore hardness.....	80	82	.....	.....	.....	65	87
% Volume change.....	....	—4	.....	.....	.....	18	....

* 1239-HCR-133 after aging 48 hr. at 300 deg. F.
† 1275-HCR-6 after immersion 70 hr. at 300 deg. F.

Ready: Collins Transmitters for airport applications

Collins Autotune Transmitters

IN DESIGN AND CONSTRUCTION the Collins Autotune transmitters, shown below, reflect extensive laboratory and field research, and intense engineering endeavor, both before and since Pearl Harbor. The most advanced refinements are combined with military ruggedness on a production line basis!

The Collins Autotune is a repositioning mechanism which quick-shifts all tuning controls simultaneously and with extreme precision to any one of ten preselected frequencies at the flip of a dial, either at the transmitter or from a remote point. The standard models are crystal controlled, and special models are available with tunable master oscillator control.

The renowned Collins pi network matches into a wide variety of single wire or vertical antennas. The 231D-13 also matches into a 600 ohm balanced transmission line from 4 to 18 Mc.

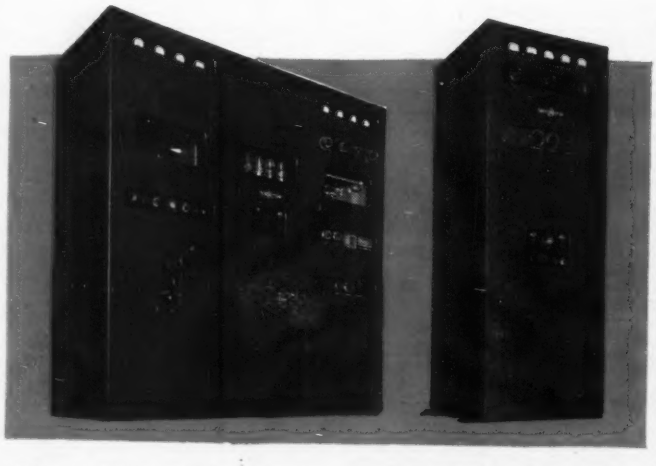
Frequency-shift keying is available, making it possible to use these transmitters in printing telegraph circuits.

Collins Multi-channel Transmitters

THE COLLINS 1000-C 2500 watt multi-channel airport transmitter shown at right, below, provides an ingenious balance of quality, efficiency and economy. The radio frequency cabinet contains two vertical r.f. sections. Each section can be used interchangeably on two channels located anywhere within 2 to 20 Mc. The cost per section compares with that of conventional single channel sections. The cost per channel is thus cut approximately in half. In addition, relays permit selection of three crystals per channel (six per vertical section). Twelve frequencies are therefore available in a single cabinet.

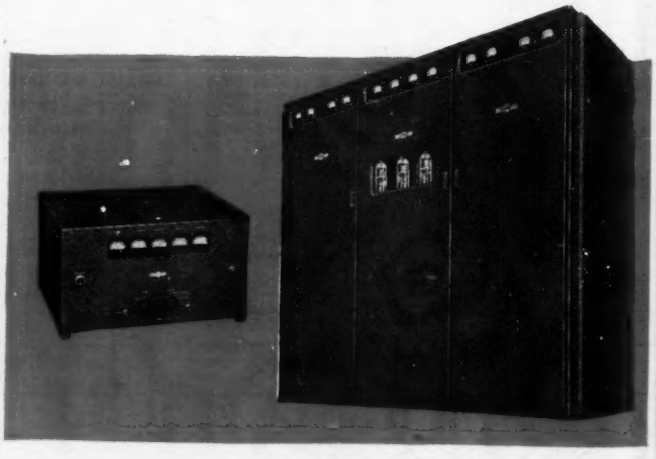
The Collins 32RA transmitter shown at left, below, is a compact low-powered crystal controlled unit which finds ready application for continuous duty in control towers, or as a stand-by. Instant selection of any one of four frequencies within its range is accomplished by means of a special gang switch actuated by a single panel control.

Your inquiry is invited. We will be glad to make recommendations for your particular applications.



Collins 231D-13—Nominal power output: 3000 watts phone; 5000 watts c.w. Frequency range: 2 to 18 Mc. Ten quick-shift frequencies.

Collins 16F-9—Nominal power output: 300 watts phone; 500 watts c.w. Frequency range: 2 to 18 Mc. Ten quick-shift frequencies.



Collins 32RA—Nominal power output: 50 watts phone; 75 watts c.w. Frequency range: 1.5 to 15 Mc. Four instantly selected frequencies.

Collins 1000-C—Nominal power output: 2500 watts. Frequency range: 2 to 20 Mc. Additional a.f.-modulator & r.f. multi-channel sections available.

COLLINS RADIO COMPANY, CEDAR RAPIDS, IOWA; 11 W. 42nd ST., NEW YORK 18, N. Y.

Collins equipment is sold in Canada by Collins-Fisher, Ltd., Montreal.

ARMY E NAVY

IN RADIO COMMUNICATIONS, IT'S...

COLLINS

REVIEW OF PATENTS

By **A. HARRY CROWELL,** *Registered Patent Lawyer*

FOLLOWING are digests of some of the more interesting recent patents on aviation developments granted by the U. S. Patent Office. Mr. Crowell will gladly furnish readers with free information on approximate cost and procedure in applying for patents and trademark registration. Address inquiries to him, care AVIATION, 330 W. 42nd St., New York City (18). Printed copies of any of patents listed are obtainable at a cost of 10c each, directly from U. S. Patent Office, Washington.

Novel Aircraft has body in general form of airfoil with plurality of spaced passages or tunnels extending through body and lifting airfoils disposed rearwardly and in alignment with some of tunnels. Means are provided for propelling airstream rearwardly over lifting airfoils to create necessary lift for vertical ascent. Forward thrust resulting from rearwardly directed airstream is counterbalanced in other tunnels to restrain craft from forward movement during ascent and descent.—2,380,535, filed Oct. 27, '41, pat. July 31, '45, J. E. McDevitt.

Rotor-Equipped Aircraft places main burden of control and sustention of craft in its rotor which, with wings positioned in autorotational incidence range, is assured of continuous rotation by aerodynamic action so long as craft is in flight, affording adequate control, even in vertical descent without engine power when there would normally remain little or no effectiveness in ordinary control surfaces. Rotor also retains capability of obviating differential lift and gyroscopic precessional effects.—2,380,580, filed Dec. 6, '32, pat. July 31, '45, J. de la Cierva, assignor (by mesne assignments) to Autogiro Co. of America. . . . . In similar field of design, patent involving same inventor and assignee is concerned with effecting control of attitude and motion of craft, controlling operation being performed on rotor blades by varying geometrical pitch angles. Advantage claimed is that control does not involve changing orientation of rotational axis of rotor hub relative to craft, and periodic change of geometrical pitch angle is imparted to rotor blades, either individually or in oppositely disposed pairs, in synchronism with rotational period, control being effected by varying amplitude and azimuth of such periodic pitch changes.—2,380,582, filed Nov. 16, '32, pat. July 31, '45. . . . . Another relevant invention, also involving same parties, is intended to improve takeoff by providing this type of craft with capability of vertical takeoff as well as vertical descent. Means for changing pitch angle of rotor blades operate automatically in response to variations of torque applied to rotor.—2,380,583, filed Aug. 3, '34, pat. July 31, '45.

Mooring Appliance for aircraft consists of U-shaped member having parallel laterally disposed flanges projecting from upper ends of leg portions and adapted to be secured to channeled wing fitting, thus providing eye for mooring line connected to ground stakes.—2,380,702, filed June 12, '44, pat. July 31, '45, M. C. Persons.

Aircraft Control Column, intended to replace foot-operated rudder control and conventional control column, is designed for activation of ailerons, elevators, and rudder so as to allow for individual movement of any of these surfaces or in combination. Feet are left free for operation of brakes or additional foot throttle, as a safety aid in taxiing, takeoff, and landing.—2,381,217, filed July 26, '43, pat. Aug. 7, '45, B. B. Harman.

Pitch Control Mechanism is designed to turn blades beyond normal pitch range arc by high fluid pressure produced by driving a fluid compressor or pump through independent means. Pitch angle is controlled by pair of centrifugally actuated counterweights directly connected to respective blades and a hydraulic mechanism operatively connected to counterweight.—2,381,362, filed Dec. 20, '40, pat. Aug. 7, '45, R. M. Nardone, assignor to Bendix Aviation Corp.

Aircraft Heating Apparatus, electrically and thermostatically controlled, embodies safety devices acting to stop supply of fuel mixture to render unit inoperative when damaged or overheated.—2,381,591, filed Sept. 22, '41, pat. Aug. 7, '45, S. E. Heymann, assignor to Stewart-Warner Corp.

Multi-Engine Propulsion System utilizing contra-rotating propellers is most efficiently adapted to wing-contained pancake power plants and embodies drive running from all engines to all propellers. Engines are arranged flatwise in wings, immediately adjacent to fuselage, with crankshafts in alignment and with output ends adjacent, common axis of engines being coincident with lateral axis of craft. Engines are interchangeable since both power shafts are similarly rotated, either clockwise or counterclockwise when viewed from output ends.—2,381,596, filed Sept. 2, '42, pat. Aug. 7, '45, M. Jensen, assignor to Langley Aviation Corp.

Wing Design embodies means for forming slot which is effective to adjust angle of incidence to maximum amount with retention of lateral control up to stall. Slot comprises plurality of sections adjacent to leading edge and extending from root to tip. Slot sections may be of different contour, length, and width, or tapered, with relation to portions of wing and chord with which they are respectively related.—2,381,678, filed Feb. 11, '42, pat. Aug. 7, '45, F. R. Maxwell. In other wing design by same inventor, interconnected slot and flap arrangement has slot provided with upper and lower covers, upper cover being locked (against opening movement resulting from aerodynamic forces acting on wing) until flap begins to move. Operating linkage is such that flap may move through small angle before slot opens, and aerodynamic forces working on wing leading edge cannot open upper cover until pilot has moved flap.—2,381,679, filed Mar. 17, '43, pat. Aug. 7, '45.

Aircraft Identification and Range estimating trainer comprises light tunnel containing target member operative back and forth, freely adjustable reducing lens sight directed at target, and means for automatically reducing and increasing illumination of target as it approaches and recedes, respectively, from the sight.—2,381,757, filed Aug. 24, '43, pat. Aug. 7, '45, J. W. Jones.

Trainer Directional Compass, designed to embody simple construction, simulates operation of usual gyroscope-controlled directional compass during flight. Compass card of aircraft trainer's directional gyro is driven at slightly different speed than trainer's magnetic compass card to

(*Turn to page* 249)

Recent Books

THE STANDARD GUIDE TO PRIVATE PLANES, by Lester Ott. Aeronautics Publishing Associates, New York City. 119 pages, photographs. $2.00.

This work furnishes key information on private planes for purchasers and pilots. Sections include articles on how to buy aircraft, aviation insurance and financing, how to fly, etc. Aircraft are shown in photographs and described in accompanying text. A list of airports and flying schools is also offered.

STANDARD AND EMERGENCY MACHINE SHOP METHODS, by Fred H. Colvin and Frank A. Stanley. McGraw-Hill Book Co., New York City. 332 pages, photographs, drawings. $3.50.

A practical manual of machine shop methods, especially demonstrating how various kinds of operations can be performed on types of machines not specifically intended for them, providing suggestions and time-saving ideas for shops which handle a variety of work. Shown, for example, is how turning is done on a drill press, a boring machine, and a milling machine, instead of in the lathe.

AIRCRAFT INDUSTRY IN CHICAGO. The Chicago Assn. of Commerce, Chicago, Ill. 226 pages.

A comprehensive classified directory of aviation trades in the Chicago region, with index.

PIPING HANDBOOK, by Sabin Crocker, M.E. McGraw-Hill Book Co., New York City. 1,376 pages, charts, graphs, index. $7.00.

Fourth edition of standard work on piping systems in modern power plants, in distribution systems, and in industrial operations.

PROCEDURE HANDBOOK OF ARC WELDING DESIGN AND PRACTICE. The Lincoln Electric Co., Cleveland, Ohio. 1,282 pages, photos, graphs, charts, index. $1.50.

Eighth edition of standard work, pointing up improvements in the electric arc welding processes that have occurred in the last few years. Book includes complete descriptions of the process in its various forms and also essential data for its use in welding various types of steel, iron, and non-ferrous metals.

INTERNATIONAL AIRWAYS, compiled by Alberta Worthington. H. R. Wilson Co., New York City. 275 pages, text, bibliography. $1.25.

Part of the Reference Shelf series, the book is a compilation of the background, proposals, and pro and con arguments about varied phases of the question: Who shall fly where? Discussion centers on national viewpoints and chosen instruments. A special section deals with the Civil Aviation Conference.

THEORY AND TESTING OF JET PROPULSION MOTORS AND ROCKETS, by Zygmunt Fonberg. Aircraft Jet and Rocket Corporation, New York City. 91 pages, text, tables, drawings. $2.

New mathematical approach presenting basic concepts and discussion of current thought in the field of reaction motors. Fundamental formulas are given, with text and drawings indicating their practical application, including the effect of thrust amplifiers.

TIME STUDY AND MOTION ECONOMY FOR SUPERVISORS, by James D. Shevlin. National Foremen's Institute, Inc., Deep River, Conn. 73 pages, text, drawings. $2.

Comprehensive study of the subject, with emphasis on efficiency, speed, health, and care of the worker.

THE MILLING MACHINE AND ITS ATTACHMENTS. Kearney and Trecker Corp., Milwaukee, Wis. 83 pages, text, photos. 25¢.

Informative booklet giving principles involved in design and construction of modern knee-type or bed-type milling machines. Subjects of cutter driving attachments, work-holding attachments, accessories, and machine controls are also considered.

TRU·LAY PUSH-PULL

. . . where control must be accurate and dependable

● Designed to the rigid specifications of one aircraft manufacturer, this improved TRU·LAY PUSH-PULL unit is now available to all.

● Where it is necessary to transmit back-and-forth action over, under or around obstacles, this unit is unexcelled. Its operation is smooth, positive, absolutely dependable. And there's practically no wear-out to it.

● TRU·LAY PUSH-PULL CONTROLS are made in a wide range of sizes and types, with end fittings designed for the particular job to be done. If you have any problem of remote control, send it to us in the form of a rough sketch—we will be glad to help you solve it.

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In Business for Your Safety

SIDE SLIPS

DESPITE THE FACT that it meant maintaining a state of complete (well nearly complete) sobriety through both V-J holidays, we enjoyed working with the crew at CAA's experimental station at Indianapolis. One of the most enjoyable and heartening of their developments was the instrument approach control system whereby the present 12-15 min. intervals required to bring planes down out of a stack can be cut to 3 min. We were in one of the planes in the demonstration stack and know it can be done—repeatedly and with pilots who haven't been practicing the routine. One of the men at the station seemed a little disappointed though; after the show was over he complained that "we wanted to simulate a stack of twelve planes, but the last one was already down before the first could get back up to the top of the stack."

• One gadget they had there certainly made us a prospect for an airplane that flies "low and slow"—at least slow. That was the gun, described in AVIATION a couple of years ago, that shoots chickens, ducks, and whatnot at windshields to test impact resistance. They fired a chicken (you know, those things you maybe can buy now) at 135 mph. through a standard windshield and darn near through the bulkhead behind it.

That's one way of getting a chicken dinner that you can have.

• You've probably heard the gags about jet engines being wonderful for that type of thing—the chicken goes in the front and comes out the back all plucked and roasted. Well, friend of ours thought for a minute he was going to have the theory tested—with his head.

Seems this jet engine was going full blast on the test stand, and our friend, in trying to trace down an oil leak, moved in a stooping position to a point about four feet ahead of and to the side of the intake. For some reason he stood up—and *wham!* All 190 pounds of him was sucked smacko right up over the nose cowling and, though he was pushing with all his considerable strength, found himself stuck, but fast. Man in the control room did a swell job of quickly shutting everything off, but even so the victim's tie was pulled around to where it was doing a good job of choking him—his neck, which was jammed up against the intake cowling, had a swelling as big as an apple pulled out on it, and his favorite fountain pen was no longer in his shirt pocket.

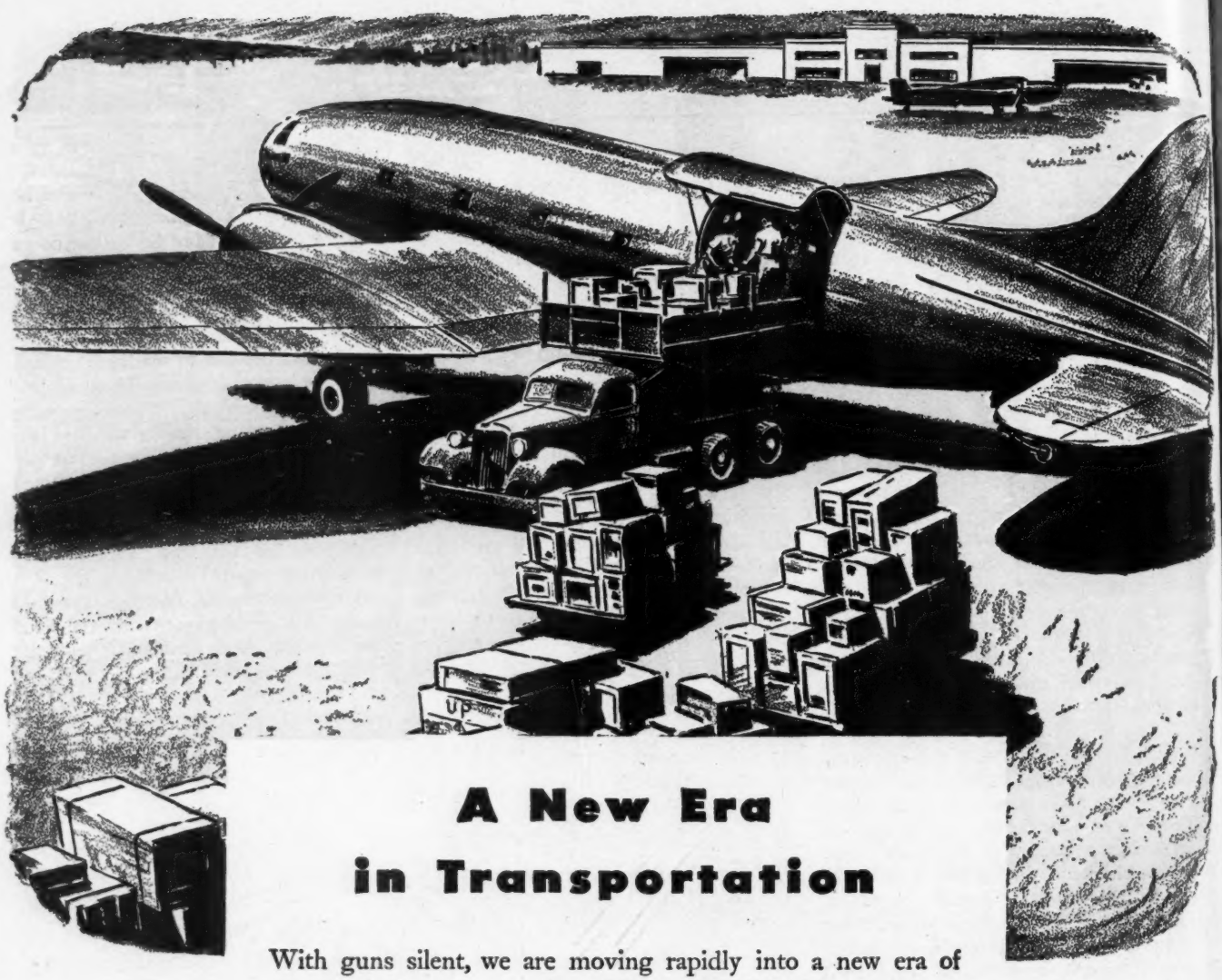
With complete scientific aplomb he reports that a fountain pen will do no damage beyond the third compressor stage; "complete disintegration takes place by then." But the nicks we saw in the first three rows of blades have convinced us we'll give just as wide a birth to the front end of a jet as we instinctively do the hot end.

• The harried operator was bemoaning the lack of a crankcase, which was keeping a badly needed trainer out of the air, when a newly-hired mechanic spoke up and said, "Ill get you one for a hundred bucks, if you don't ask any questions." Knocking his conscience cold in less than 30 seconds, the operator agreed and, sure enough, the next day the mech supplied the case and he had to write out a check for $100. It was a tough fight, but he fought down his curiosity and asked no questions.

Later that day he started looking for two mags off an engine from a crackup and finally found that this same mechanic was the last to see them. When asked what happened the fellow replied calmly, "Oh, I threw 'em out the window." Turned out that the window just *happened* to be right alongside a road. Whereupon the operator really started inventorying everything. Heading the list of missing parts was a crankcase from one of his own engines then undergoing repair!

For some reason, nothing was said when he stopped payment on the hundred dollar check and hung out the "Mechanic Wanted" sign.

"Maguire says those postwar products are as oversize as they are obsolete—he's now going in for atom capsule power units."



A New Era in Transportation

With guns silent, we are moving rapidly into a new era of expanded air transportation. Not only will millions of passengers be transported over land and ocean . . . but countless tons of fast freight will be moved by plane from national and international ports.

Already, Holley Carburetors are playing an important part in this epochal expansion. Through experience gained in millions of miles of wartime flying, Holley research advanced and improved aviation carburetion during war years. Now, as this new era in transportation gains momentum, Holley will, as it has done for almost half a century before, set the standards of dependable carburetor performance.

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AIRCRAFT, AUTOMOTIVE, MARINE

CARBURETORS AND ACCESSORIES

THE AVIATION NEWS

BLAINE STUBBLEFIELD, Washington HERB POWELL, New York E. J. BULBAN, New York

Military Lines Up Vast System of Air Bases; Also Accents Key Study of Bombing Results

. . . Single-engine restrictions weighed in N-S checkup . . . ATSC center is pushing rocket development . . . Points out responsibilities of personal flyers . . . Notable progress achieved in air education . . . Mechs get refreshers.

The Navy (and presumably the Army) plans a vast system of bases—especially in the Pacific, up to Japan's doorstep, and also in the Atlantic—to forestall any future attempt at aggression. Air installations would be accented.

Presently suggested are nine Pacific bases, including Guam, Wake, Philippines, Kodiak, the Aleutians, Hawaii, Canal Zone, Saipan, Bonins, and Volcano Islands. In addition there would be ship anchorage and airfield auxiliary stations. The six in the Atlantic are in the Caribbean area.

Adm. Nimitz suggested that Navy bases be equipped and available for use by commercial airlines. Asst. Sec. of Navy Hansel said materials for such bases would cost more than $2,000,000,000. The program, of course, will be decided by Congress.

Accent Put On Study Of Bombing Results

Exhaustive study of the effect of bombing in Europe still continues, while a like investigation is getting started in Japan, where the targets and the types of bombs used were quite different.

"For the first time in history," said AAF Chief Gen. H. H. Arnold, "a major world power (Japan) capitulated with its armies still intact. The B-29 was responsible."

Obviously such unprecedented results of combat are a matter of major interest to the Army and to the people of this country. Investigation will be long and complete. Top study will gage results of the two atomic bombs dropped on Hiroshima and Nagasaki.

Until the world security organization is effective, U. S. armed forces will hold all of its technological secrets under tight restrictions. World-wide controversy over atomic know-how, now in possesssion of only the U. S. and Britain, is already brewing. Indications are that harsh words will be used by groups of different viewpoints, and that in the end Congress will clamp on the lid.

Single-Engine Restrictions Weighed in N-S Checkup

CAB's proposed operating regulations for non-scheduled flying appear to disfavor extensive use of single-engined airplanes. One question accompanying proposed Part 42 inquired whether single-engined planes of less than 100 hp. should be restricted to 500 mi. from base by day and 25 mi. by night, unless each occupant had a parachute, or unless the flight is confined to the area of a lighted airway.

It is proposed that single-engined craft of any power rating be restricted from overwater, except when taking off; that seaplanes stay within gliding distance of open water; that single-engined planes shall not operate at night, except under conditions specified in operating certificate.

Some experienced airmen believe that restrictions on single-engined airplanes are a hangover from times when engines were nowhere near as reliable as they are now. It is known that at least one member of CAB was favorable toward use of large single-engined planes for passengers by day, and for freight-only at night. (Further news of non-scheduled flying proposals appears on page 217.)

ATSC Center Is Pushing Rocket Developments

A rocket center is being operated on the Atlantic Coast by the Air Technical Service Command. It has approximately 200 engineers and technicians engaged in the fabrication and testing of all kinds of rockets and launching devices.

The center consists of shops and a hangar, offices, administration building, photographic laboratory, supply organization, and aircraft maintenance personnel.

ATSC says it can tackle any rocket problem. The range, equipped for firing from ground and plane, is staffed by personnel from the Army's Ordnance Department, assigned to AAF.

Liaison is carried on with similar development work by the Navy, National Research Council, Ordnance Department, and private institutions like California Institute of Technology and George Washington University.

Development of rockets permits aviation to carry fire power equivalent to that of heavy guns, and without the great weight, since rockets carry their own propulsion.

HIGH SPEED "FENCED IN"

Northrop P-61C Black Widow has "picket fence" brakes above and below wings to slow it down when closing in for battle. Developed by Northrop Aerodynamicist Irving Ashkenas, brakes do not affect flow of air over wing, rather are counteracting to facilitate action which is imparted by hydraulic motors actuated through pilot's foot pedals. Other changes include installation of turbo-supercharged P & W R-2800-C's in re-designed cowling and use of Curtiss paddle-blade props.

Points Out Responsibilities Of Personal Flyers

Responsibility of private flying for its own acceptance by the public is again emphasized by John H. Geisse, Assistant to the Administrator of CAA. Mr. Geisse previously warned personal aviation that if it did

Coming Up

Oct. 4 and Nov. 1: SAE Southern California Section Aeronautic Meeting, Hotel Biltmore, Los Angeles.
Oct. 6 - 14: Detroit International Air Show.
Oct. 8 - 14: Fourth Michigan Aviation Week.
Oct. 12 - 13: Soaring Society of America, Annual Conference, Polytechnic Institute of Brooklyn, N. Y. C.
Oct. 15: Provisional International Civil Aviation Organization Interim Council, Montreal.
Oct. 16: International Air Transport Assn., First Annual Meeting, Montreal.
Oct. 25: IAS Air Transport Meeting, Washington, D. C.
Oct. 31 - Nov. 3: 1945 National Aviation Clinic, Oklahoma City. (Pre-clinic conferences start Oct. 27.)
Nov. 5 - 6 - 7: National Assn. of State Aviation Officials, Annual Meeting, Coronado Hotel, St. Louis.
Dec. 17: IAS Wright Brothers Lecture, Washington, D. C.

not practice sane flying, regulations would be stiffened again.

This time Mr. Geisse says that American communities will not tolerate airports in their midst if low flying and unsightly field premises are continued.

The personal flying fraternity will need more airports if it is to thrive, he points out. Therefore, pilots should do everything in their power to win the favor of the public. He suggests that they stop buzzing houses, go around instead of over communities, and stop flying low insofar as possible.

Trucks passing in streets actually make more noise than airplanes do, but people are not used to the airplanes. Probably technologists can curtail airplane noise, but more consideration regarding the din is recommended till they do.

Some airport shabbiness is caused by lack of capital for proper improvements and maintenance, but most managers can readily make their premises look better as a matter of pride.

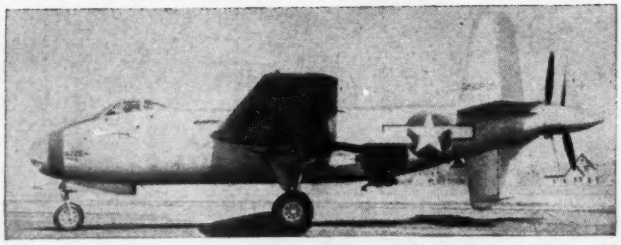
Notable Progress Achieved In Air Education

At present more than a score of both civilian and governmental organizations, particularly schools, are promoting projects in various aviation fields, says the Air Transport Assn.

It is estimated that 96% of the colleges and universities in the U. S. now recognize aeronautics as an elective science, with curricula ranging from 4-5 yr. study in aeronautical engineering down to summer school short courses lasting only a few weeks.

Secondary schools in states representing 50% of the population have also made comprehensive peacetime aviation programs.

The whole aviation educational program has been given a considerable boost with the AAF's gift of some $38,000,000 worth of aircraft equipment to non-profit schools for non-flying activities.



SHALL WE SAY—UNORTHODOX?

Your eyes are right—those props are aft of the empennage. Craft is the Douglas XB-42, sometimes called "Mixmaster," an experimental 35,702-lb. gross wt. bomber powered by two Allisons inside fuselage (just ahead of wing) driving contra-rotating propellers. With speed of over 400 mph., it's first bomber to hit such a rate. Note air intakes in leading edge of laminar flow wing, also observe how main landing gear retracts aft and into fuselage. This design may well be forerunner of DC-8 (see data on latter craft included in special article on new Douglas types, page 108).

Mechs Get Refreshers

A mechanics' refresher training program has been set up in AAF, in cooperation with CAA, and many of the 1,400,000 AAF personnel now being released will receive CAA mechanic certificates prior to their discharge. The mechanics are seriously needed in air transport and other air services.

A sample examination at Bolling Field, Washington, D. C., revealed that many AAF mechanics are weak in civil air regulations and regarding propellers, many having had no experience with wooden props. These subjects are being emphasized in training.

★ SPOT CHECKING ★

Cleveland Air Races are planned again next summer, and one of highlights proposed is race event for jet-propelled craft, with a special trophy to be awarded by Weatherhead Co.

A resolution dealing with development and financing of airports was adopted by Joint Legislative Committee on Interstate Cooperation. Proposal calls for maintenance of federal-state-local pattern of cooperation in developing airports, instead of a federal-local pattern such as is being considered in two pending Congressional bills.

A personal flying boom along West Coast is reported by CAA, with student certificates granted up 160 percent, identification cards granted up 140 percent, written exams given up 240 percent, pilots certificates and ratings issued up 160 percent, and aircraft certicated up 170 percent. Further, 1,000 surplus aircraft have been purchased in this region in past 9 mo.

Capacity of flight, in its latest forms, to affect nearly all human affairs is felt to be almost too much for any one political, social or technical group to cope with. There's now increasing speculation anent a comprehensive "Morrow" board, to study and advise how aviation can best be used for good in this country and people everywhere.

That many foreign operators want U. S.-built transport craft is revealed in a survey made by FEA. Findings show that foreign lines want more than 90 planes weighing 50,000 lb. or over, indicating a potential business for American builders of about $50,000,000. These operators are also looking for about 195 craft between 25,000-50,000 lb., adding another $25,000,000 in business; also about 40 smaller craft, which would amount to another $4,000,000 worth. Among interested buyers mentioned are Sweden, Brazil, Australia, Belgium, France, Spain, Argentine, Denmark, and Netherlands.

A new interphone radio amplifier for use at high altitudes has been developed by AAF. Unit weighs about 7 lb. and has four tubes instead of one, with a resulting increase in sensitivity and amount of sound energy transmitted.

A flapping-wing model airplane contest originated by William B. Stout is being sponsored by National Exchange Club. Purpose is to develop successful ornithopteral designs. Any American boy or girl under 18 may enter. Prizes range from $25 to $100 in Victory Bonds.

GM's 200-hp. aircraft engine is now known to be a 4-cyl radial type utilizing a blower, and it is minus valves, this function being handled by pistons. Piston displacement is given as only 250 cu. in., and dry weight of engine is only 275 lb. Fuel consumption is stated to be about 13 gal. per hr. using 91 octane fuel. It is rumored that one of company divisions will put it into production soon.

Globe Swift Craft is to be fitted with 115-hp. Continental engine. Estimated performance figures with this power plant will be a minimum 135 mph. cruising speed (at 75% hp.), takeoff run of 600 ft., rate of climb of 850 fpm., and a service ceiling of over 16,000 ft.

First Arizona statewide aviation conference will be sponsored by Tucson C. of C. in Tucson on Nov. 15 and 16. Purpose of meeting will be to obtain latest information regarding airports, airport management, problems of personal flyers, information on commercial airlines development, and the like.

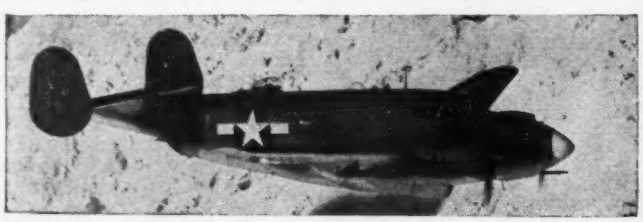
WPB has set up machinery to help find jobs for men and women on its staff. Chairman Krug announced formation of WPB Industrial Personnel Committee (Rm. 2060, Railroad Retirement Building, Washington). Bureau will serve as a contact point between personnel and industry.

Olympic Div., Hamilton Radio Corp, N.Y.C., recently chartered a Lockheed Electra to conduct a 7,000 mi. tour of concern's major distributing centers. Plane enabled party to cover country in only 43 hr. of flight time. Carried were 1,100 lb. of sales equipment which was always available for demonstrations. Officials stated that trip convinced them that, "this transportation medium is ideal for modern executive selling tour."

New publications: Pocket-size booklet by Firestone, entitled *Make the Skyways Your Highways—Learn To Fly,* is being used by company's aircraft dealers to develop interest in flying and to aid students. It illustrates flight maneuvers and advertises firm's aviation products . . . Prepared by Research & Planning Dept., South Carolina Aero Commission's, "Report of South Carolina's Air Transport Potential" gives facts and statistics on business possibilities in state. . . . "Plan for Expansion of Airport Facilities of Greater Cleveland" is report by Committee on Airports of Cleveland C. of C. . . . Publication by U. S. Dept. of State, *Blueprint for World Civil Aviation* contains viewpoints of four members of U. S. delegation to 1944 Chicago International Conference . . . "An Open Book" is presentation of facilities for manufacturers in Massachusetts, with aviation particulars noted. It is published by Massachusetts Development & Industrial Commission, 224 Park Square Bldg, Boston.

Prize contest, to initiate Whittlesey House Fellowship Awards for books on scientific subjects written for laymen, offers $5,000 top award, with $1,000 each for other book projects accepted for publication. Rules stipulate that entrants must submit by Dec. 1, 1945, a complete plan for book, together with about 10,000 words of manuscript, which when complete must range from about 80,000-150,000 words. Candidates must also submit details on amount and type of research intended. Completed manuscripts will be required of contestants no later than Dec. 1, 1946. No limitations are placed on subject matter, except that it must deal with the scientific. Material might be a scientist's biography or autobiography, or be a book of general interest, dealing with some development in a specific scientific field. Detailed information can be obtained from Whittlesey House, McGraw-Hill Book Co., 330 W. 42 St., N.Y.C. (18).

Value of models in planning production lines for mass output was demonstrated to members of press at a recent gathering sponsored by Westinghouse in N.Y.C. Having received increased orders for Navy HVAR rocket projectiles, company planned maximum use of minimum plant space by constructing ¼-in. scale models of machines, equipment, and person-



WINGED HARPOON

Long held on Navy secret list, this Lockheed PV-2 Harpoon search plane was developed from well-known PV-1 Ventura. Powered by two 2,000-hp. R-2800 P & W's, craft has top speed of over 300 mph., range of more than 2,000 mi. and can lug 4,000-lb. bomb-load. It can also carry torpedos and rockets. Design changes include: Addition of 135 sq. ft. of wing area (by increasing outer panel span); new empennage to give larger control surfaces; greater fuel capacity, with self-sealing fuel tanks; curved windshield with re-arranged pilot's seat; and increased forward firepower.

Sitting pretty . . .

and 7 pounds lighter

Made of Mazlo Magnesium, this new lightweight seat, designed by Douglas Aircraft Company engineers, reduces the weight per 21-passenger plane by 147 pounds. Yet it costs but slightly more than half the price of the old type chairs. This savings in weight alone, can mean an added passenger, or the revenue on 147 pounds of cargo.

Here's something to think about when designing tomorrow's passenger, cargo and personal planes. Magnesium alloys give the required strength and dependability, along with maximum savings in weight.

American Magnesium engineers will gladly sit down with you and help you employ magnesium to best advantage. Write Aluminum Company of America, Sales Agent for American Magnesium Products, 1713 Gulf Building, Pittsburgh 19, Penna.

MAGNESIUM MAZLO PRODUCTS

AMERICAN MAGNESIUM CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA

"the choice of better mechanics"

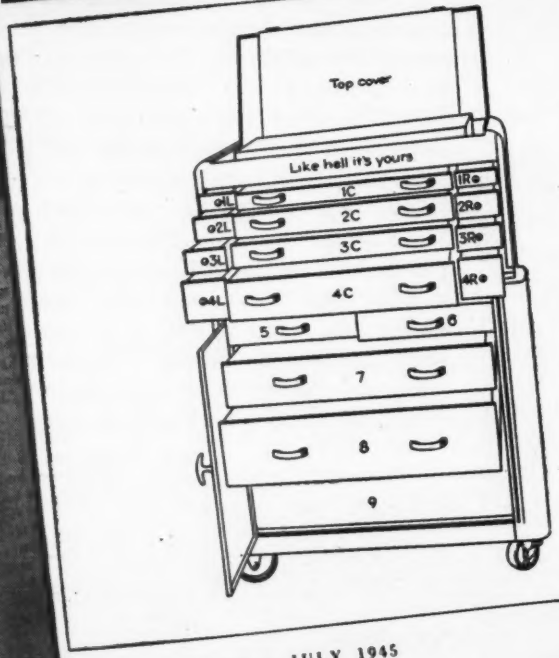
Everything in Its Place

Winston A. Peacock, Northeast flight mechanic, displays his Snap-on chest for the tools he uses in his job. He was a member of the NEA 5-man crew that flew a rescue mission of nearly 10,000 miles in the Arctic regions. For circling the magnetic pole, bringing out an ill weather observer, dropping two meteorologists at a post above the Arctic Circle and delivering 2,000 lb. of radio equipment and food to lonely outposts, Air Medals were awarded to Capt. Alva V. R. Marsh; Francis B. Chalifoux, copilot; Joseph Sewall, navigator; Lester E. Hughes, flight radio operator; and Peacock, the flight mechanic.

In the tool kit, illustrated, Mechanic Peacock has these tools, which are mainly from Snap-On Tools Corp., Kenosha, Wis.:

1L—Files to 10 in.
2L—Misc. drills, keys, hole finders.
3L—Solder rolls, thread, flashlight batteries, boiler gaskets and parts.
4L—Bevel protractor, cotter pin pullers, lathe tool bits, misc.
1C—¾-in. drive ferret set, screw extractor set, midget socket set, misc. open end wrenches.
2C—Complete set of taps and dies from 4-40 to 1 in.
3C—½-in. drive set of sockets, complete long set of sockets, tube cutter, stud remover.
4C—Complete set of box sockets. Torque wrench, set of combination open end wrenches, open end wrenches 5/16-in. to 1½-in., tube flaring tool, dividers (2 pr.).
1R—Drill gages, thread gages and feeler gages. Micrometers, automatic center punch, small mirrors.
2R—Pliers and diagonal cutters.
3R—Screwdrivers.
4R—¾-in. drive sockets.
No. 5—Sheet metal tools and bucking bars.
No. 6—Set of flare nut wrenches, set of hydraulic tools.
No. 7—Misc. pipe fittings and nuts, pipe cutter, compression tester, misc. tools.
No. 8—3 complete sets of drills, large hammers, soldering irons, Stillson wrench, set of large files, set of telescope gages.
No. 9—Misc. collection of cements, fluxes, etc. Timing light, ring compressor and masking tape.

Collected in the top of the kit are: A set of 1 to 60 drills; long extension drills; tote tray; welding goggles; lighter; and a miscellaneous collection of nuts, screws and bolts. Mechanic Peacock also has a simple, special wrench for removing retaining nuts on a Goodyear brake and another for tightening Douglas window pulls.



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AIR TRANSPORT • JULY 1945

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SNAP-ON TOOLS CORPORATION 8020-J 28TH AVE. KENOSHA, WISCONSIN

nel. Using these, it was possible to decide far more efficient placement of facilities than if layout had to be visualized from two-dimensional paper templates. Models made it possible to visualize materials arriving at, and flowing from, work stations at correct height for greatest ease of handling.

Static test model of Howard Hughes F-11 photographic plane for AAF has been completed, and test flights are expected soon on craft. Patent drawings show plane to be twin-engine type with twin tail booms and central crew nacelle.

Stinson's latest entry into personal plane field is Voyager 150, bearing some resemblance to Voyager 125. Powered by a 150-hp. Franklin, craft is four-placer with cruising speed figured at 125 mph. over 500-mi. range. Top speed is estimated at 133 mph., and rate of climb at 770 fpm. New all-metal tail is feature.

Average hangar rental for personal planes in U.S. is $15 monthly, according to a survey conducted by Aero Training Society among service operators in all parts of country. Since this cost is one frequently mentioned as an expense item from which owners and prospective owners most frequently shy, ATS Sec. Wayne Weishaar states that his organization is studying ways and means to reduce these rates.

National airport program of 3,000 new fields, pending before Congress in several bills, was being held up at this writing because of urgent re-employment and industrial conversion legislation.

Five-page guide is being issued by CAA to assist persons interested in starting small airports. Pamphlet lists offices and locations of CAA District Airport Engineers, familiar with requirements of various states, who are ready to advise persons. In addition, CAA has made available economically-priced booklets as further aids to such projects. Priced at 15c, *Airport Design* promotes safety features. Others are, *Small Airports, Airport Management, Airport Planning in Urban Areas, Seaplane Landing Facilities,* and *Information on Small Airports.*

★ CANADIAN NOTES ★

By James Montagnes

First use of radar for commercial airlines is by Trans-Canada Air Lines, which has installed an experimental station at Winnipeg headquarters for use on transcontinental operations.

Practically all aircraft contracts have been cancelled at Canadian airplane plants, and by early winter most employees will have been laid off. At Toronto, Victory Aircraft is finishing first five of an order of 100 Lincoln bombers, other 95 having been cancelled, and de Havilland is finishing 40 Mosquitos from an order which originally totaled 1,500 and at cancellation date amounted to 1,153. Boeing of Canada, at Vancouver, has had its subcontract for B-29 center sections cancelled along with U. S. terminations.

In Montreal, Noorduyn had its contract for North American design Harvard trainers cancelled. No word has been received at this writing on government-owned Canadair Ltd., making military version of Douglas DC-4 for RCAF, but it is anticipated this will be stopped and DC-4 aircraft will be built for Trans-Canada as originally planned. Canadian Car & Foundry plants at Fort William, Montreal, and Amherst ,working on U. S. Navy contracts, were affected, as were American plants on Curtiss Helldivers and Grumman Tigercats. Company has produced its first Burnelli flying wing, a peacetime aircraft, for which it holds British Empire manufacturing rights.

Trans-Canada has ordered seven new Douglas DC-3's for use on main inter-city routes, but not on its full transcontinental line. Some months ago it bought three surplus DC-3's, and it expects to put these on Toronto-New York, Toronto-Windsor, and Toronto-Montreal runs as soon as reconversion is completed.

Canadian Air Transport Board has approved first non-scheduled service licenses since it was formed last autumn. These are for services in gold mining and lumbering districts, having been issued for use at Yellowknife, Northwest Territories, for operations out of Edmonton, Vancouver, and Rainy Lake, Ont. Applications for a number of other such services into northern Canada have been made. A license stipulation is that licensee have sufficient capital or put up bond that when its aircraft are forced down or meet with accident in northern bush, rescue flights can be guaranteed.

Plans by Trans-Canada for service to West Indies and South America call for a route out of Montreal to Bahamas, Jamaica, and Trinidad, with a second to Bermuda to take care of heavy winter tourist traffic.

Northwest Industries, Ltd., Edmonton, is to build Bellanca Skyrocket and Aircruiser, it has been announced by Pres. Leigh Brintnell, a veteran Canadian bush pilot and airline operator. By year end, he expects to employ 400 workers.

A maintenance command has been established by RCAF at Ottawa for procurement of all RCAF supplies, inspection, distribution, installation, and salvage of all equipment, also disposal of surplus war equipment.

FOOLER FOR SPOTTERS

. . . But those who take pride in their recognition ability shouldn't be flunked for failing on this, for it's the only plane of its kind—the XB-32 with double tail and pressurization equipment. Production B-32's (see article page 106, Sept. "Aviation") feature huge single fin and rudder, and pressurization originally planned for standard model was designed out.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

Top officials of the Navy still do not admit that seapower's main forte is as a support of naval aviation. They merely say that aviation should be further "integrated" with the fleet.

All other weapons became as obsolete as the bow and arrow when the atom bombs went off over Japan—in the opinion of one high military authority. Probably exaggerated, but worth thinking about.

Opinion differs on the terror of atomic bombing. Some observers, after saying that this weapon will be too costly for use on any but major military and production installations, go on to contend that, with bombatomizers, accented, war would be quicker and easier on life than it is now.

The year 1946 will begin an era of vacation flying imagined by few. Aero staterooms, bars, meals, amusements, noiseless and vibrationless comfort, and dependable schedules, will attract thousands of long-trippers, all seasons. Fast runs at moderate prices to foreign places never before reachable to two-weekers will be a new thing in the world.

CAA methods and facilities already are standard in Canada and Mexico. The U. S. airline administrative system is available to all other American countries, some of which join in the hope that airline practices may be standardized throughout the hemisphere. Brazil and Peru are currently interested.

Peace brings resumption of the old battle by the railroads and steamship lines for an "integrated" U. S. transportation system, including also air, buslines, and pipelines (see article, page 185). Key objective is to file aviation's competitive teeth. Those who believe that this would rob the country of air transport's brilliant promise in public service, will have a hard fight to prevent a damaging compromise of this issue.

Combination aircraft, featuring both vertical-lift and horizontal flying facilities, have been suggested by NACA engineers as a basic design for experimentation. In the opinion of some civil aviation officials in government, these machines look like the beginning of a type that will have enough utility for a mass market.

★ CALLING NAMES ★

Frederic W. Conant has been elected senior v.-p. of Douglas Aircraft.

Frederic C. Cross is new chief resident counsel for Glenn L. Martin.

AIA appointments: **W. L. Wells** was elected national chairman of airworthiness requirements committee . . . Newly elected executive board of aircraft technical committee includes: **Walter Jamouneau,** eastern region; **Harold W. Zipp,** central region; **Arthur E. Raymond,** western region; **Ben T. Salmon,** and **T. A. Wells** . . . **Phillip Hartmann** has been named mgr. of N. Y. office of Aircraft Manufacturers Council . . . **James L. Straight** has resigned to join industrial concern related to aviation manufacturing.

Aerosphere appointments: **Charles E. Thorp** became executive editor and publisher, following resignation of **Glenn. D. Angle,** who is now a private consultant; **Louis Bruchiss** is editor of engines section; and **Lucien Zacharoff** became editor of aircraft section.

C. H. Brubaker has been appointed chief industrial engineer at Convair's Vultee Field. **George F. McLaughlin,** veteran aviation editor, is now director of publications, McLaughlin-Carr Associates.

Frederick L. Hovde, now on leave to head government's rocket-development program, has been appointed pres. of Purdue University.

(Continued on page 219)

CUT THEM FASTER . . .

SOME OF THE 130 MATERIALS — many brand new — now available for civilian production, that can be cut faster and better with

DoALL Zephyr!

METALS and ALLOYS

Aluminum
Armor Plate
Babbitt Metal
Brass
Carbon Steel
Cast Steel
Chromium Steel
Copper
Gray Cast Iron
Illium
Kirksite
Magnesium
Manganese Steel
Malleable Cast Iron
Nickel Chromium
Nickel Steel
Silicon Manganese
Silver
Stainless Steels
Tungsten Steel
Zinc

PLASTICS

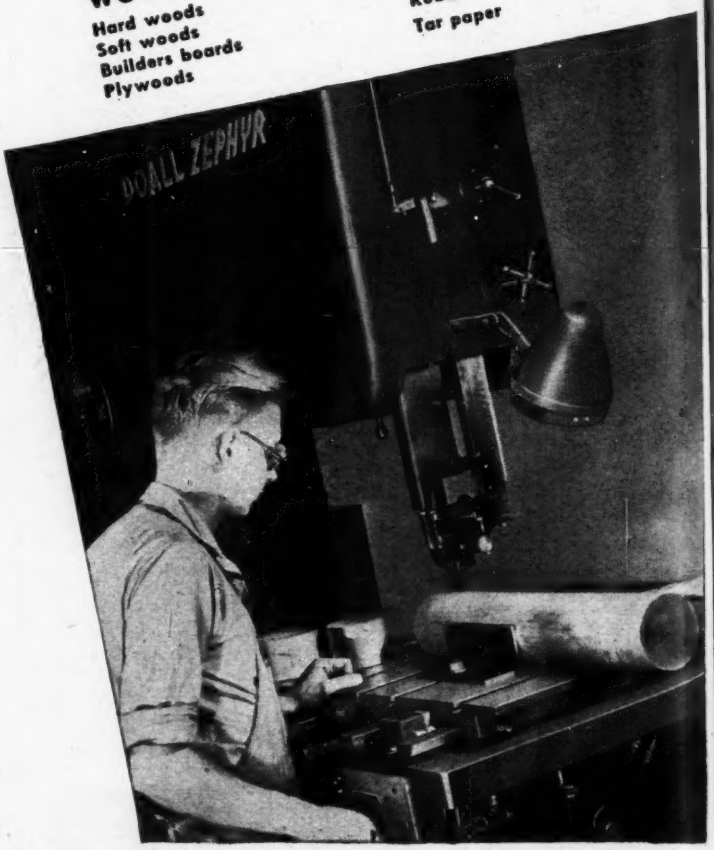
Methyl Metacrylates
Cellulose Acetate and Butyrate
Phenolic, Cast
Phenolic, Laminates
Phenolic Moulding
Polystyrene
Urea
Vinyl Resin

WOODS

Hard woods
Soft woods
Builders boards
Plywoods

MISCELLANEOUS

Aluminum foil
Asbestos
Brake Lining
Bone
Carbon
Insulating wool
Leather
Mica
Paper
Refractory brick
Rubber
Tar paper



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Military Designers Face Interim Problems; Engine Industry Yoked by Heavy Surpluses

. . . APB, ARCO, and ASU now dissolved . . . Contract terminations speeded by ATSC . . . Plant disposal problems cited in surplus study . . . Aircraft materials freed . . . CMC readies light engines

Much will be heard, beginning now, of the "interim period" in air warfare. Just as our military aviation was beginning to develop under the new technological ceilings raised by supersonic airfoils, high-power engines, jet propulsion—and the increased performances that go with them, plus all manner of accessories for more effective attack and more protection for personnel and better communications—a whole realm of un-manned, guided powered missiles was suddenly brought in. This means "signals over."

Rocket and jet-powered bombs, carrying explosives, fire, chemicals, gas, and of course the incrediole atomic disintegrator of life and property, seem destined extensively to displace airplanes, as we now know them, for combat purposes.

General of the Army H. H. Arnold, Chief of the Air Forces, addressing himself to the nation as he prepared to relinquish his large task, pictured air war in the future as moving over from the strategic bomber to missles guided by reactions to heat, light, or metal in the target, or by airborne television. These reaction-propelled missles, he said, will have a speed that will make them nearly impossible to shoot down.

The General also anticipated new communications which will make possible precision coordination of air and ground forces, also extraordinary techniques for launching, landing, and supplying airborne forces, which can be dropped completely equipped at any point in the world in a few hours.

Basic rule for American security, Gen. Arnold said, should be a balanced combination of maximum striking power, shortest possible period of build-up, and minimum expenditures.

In the interim, the General said, the nation will continue its development of heavy bombers, like the Boeing B-29, and other combat planes, with intensive research on new types.

No authoritative statements on peacetime air power can be made until Congress itself decides. One informed spokesman for AAF recently said that the Army should maintain a force of 7,500 planes, manned by 700,000 personnel. But the needs of AAF have been estimated by others at 12,000 planes, and more.

Sec. James Forrestal of the Navy stated not long ago that the fleet should have about 400 ships and 8,000 aircraft in active commission. But Navy press representatives have shown a news reel in which an air arm of 12,000 planes is called for.

Vice Adm. Marc A. Mitscher, deputy chief of naval operations (air) stated that U. S. 45,000-ton carriers should police the oceans at all times; 4,300 aviators and 2,600 crewmen should be trained each year; and 3,000 new planes should be added each year.

Engine Industry Yoked By Heavy Surpluses

The aircraft engine industry is seriously threatened by its war surplus. It is unofficially estimated that 100,000 new engines of all sizes and types were in "pipelines" from factory to war fronts on V-J Day. About 671,000 engines were produced for Army, Navy, and export in the 4-yr. period ending with 1944. An undeterminable number of that total, new and overhauled, will be available to surplus, in addition to the pipeline engines.

Most engineers agree that high-altitude combat-type engines, including liquid-cooled models, could be converted for commercial use. But there would really be no point in conversion, with thousands of "civilian" types in surplus, mainly used in war on transports and trainers.

It is expected that the market will quickly absorb all the small engines suitable for personal and light transport planes. But engines in the 800-hp.-plus class remain in quantity, it is said, to supply world air transport for years. Of course all existing engines will be obsoleted in time by design improvement, and there's the factor of the shift to turbines and jets.

In an initial test-sale, approximately 19,000 surplus war aircraft engines are being offered by Surplus Property Div. of RFC, Washington, D. C. Engines are in two categories: (1) Standard types and models approved for and currently used in commercial and private aviation, or suited to a present market in aviation, and (2) obsolete models and those unsuited without extensive modification. Category 1 engines will be sold at prices bearing fair relationship to manufacturers' prices for same type of engine and Category 2 units at prices bringing maximum net return to government.

The sale is a request for bids, which will be received from Oct. 1 through Nov. 14 and opened on Nov. 15. After prices have been established for engines of same model and "reported condition," sales will be made for an amount equal to or above the price set for engines of the same group.

Engines are located at 75 points in 26 states, and approximately half of the units are installed in planes, others are crated or coated with preservative. Dismantling for inspection will not be permitted.

Of the total offered, there are 234 Franklins, 151 Jacobs, 4,658 Lycomings, 3,570 Allisons, 244 Packards, 4,263 P & W's, and 5,953 Wrights. About 26 percent are under 400 hp., 25 percent 400-650 hp., 44 percent 800-1,200 hp., and 5 percent over 1,200 hp. About 306 are new, 332 used but reconditioned, 9,271 used and usable without repairs, 8,929 used and usable with repairs, and 235 of no further use as originally intended but of possible value other than scrap. While some have all usual accessories, others may have only a few, and some none. Sales will be made on an "as is, said to contain" basis. Before these engines may be used in civil aircraft, they must pass CAA inspection.

APB, ARCO, and ASU Now Dissolved

Dissolution of the Aircraft Production Board, a war agency operating under the War Production Board and composed of representatives of WPB, War, and Navy, became effective Sept. 30 by order of WPB Chief Krug. APB directed all aircraft production during the war.

The Aircraft Resources Control Office (ARCO) and the Aircraft Scheduling Unit (ASU) operating under authority of APB, also are dissolved. Mr. Krug said that the APB-ARCO-ASU program had been an outstanding example of coordinated federal activity.

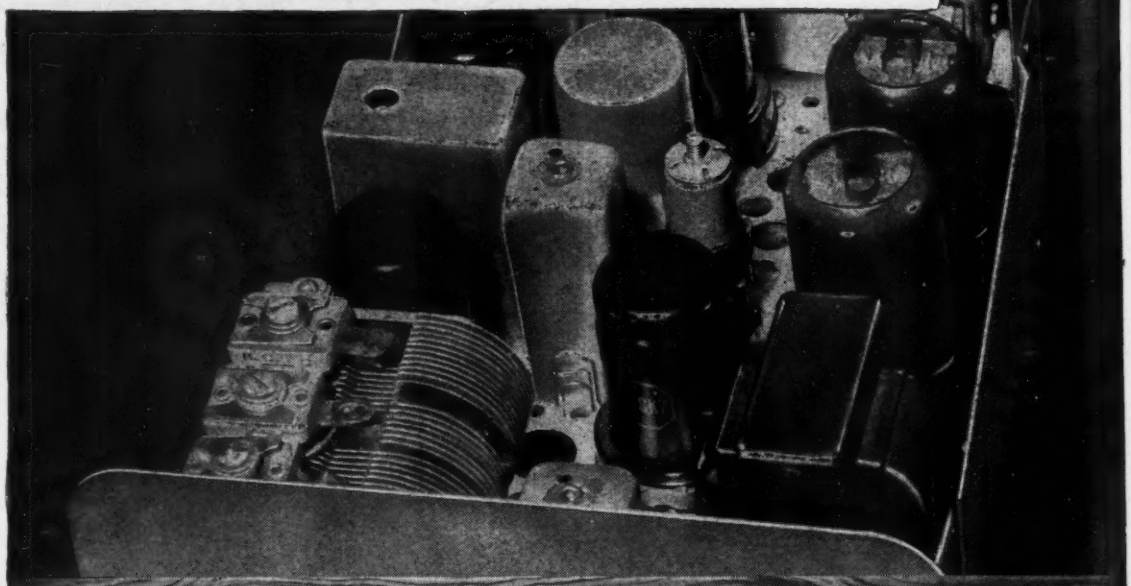
Presumably the Aeronautical Board, joint Army-Navy air policy making group, all but forgotten during the war, will resume its functions of determining cooperative standardization of aircraft and components and facilities. Its members are appointed by the President.

"DIRECT FROM PRODUCER TO CONSUMER"

Cutaway showing innards of Bendix direct fuel injection system developed for Boeing B-29. Here Project Engineer John Marshall (center) tells Frank C. Mock (left), manager of Bendix-Stromberg carburetor engineering, and C. D. Manhart (right), aircraft fuel equipment sales manager, how fuel-air mixture comes from pumps, synchronized with Wright engines, at pressures ranging from 500 to 2,500 psi. Flow is through line at left of head, then through nozzle directly to cylinder, at maximum rate of 20 times per second.

The PXer

by LEAR, Incorporated



A New Low-Cost Transmitter-Receiver for the Private Flyer

As soon as the bars come down, private flyers will have available a new high-efficiency radio such as they've never seen before—the Lear PXer.

All of Lear's experience with aircraft radio since 1930, plus the great advances made during the war, are reflected in this new, compact, low-weight radio instrument.

It is far-reaching, easily installed, dependable, and low in cost.

This is a transmitter-receiver flyers have always wanted. Perhaps you would like to be distributor for it and other Lear Radios. Some valuable territories are open to qualified representatives.

If you are interested, get in touch with us. Write LEAR, Incorporated, Aircraft Sales Department, 110 Ionia, N. W., Grand Rapids 2, Michigan — Phone: 6-9651, Ext. 52.

LEAR RADIO

Lear INCORPORATED

Powers of the Board, or of some other agency that may be set up to replace it, will be involved with the inevitable controversy over unification of the armed forces under one defense officer in the Cabinet.

Contract Terminations Speeded by ATSC

Air Technical Service Command at Wright Field is expediting the settlement of 9,800 Air Force war production contracts spread among 2,900 prime contractors and aggregating $11,000,000,000 for AAF equipment, in force on V-J Day. A majority of the contracts were completely terminated with announcement of Japan's surrender, but some were subject only to partial cutbacks, and many for experimental work were not disturbed at all.

Of these thousands of firms drafted for wartime aviation production, not more than a score, says ATSC, were members of the peacetime aviation industry.

ATSC, under the command of Maj. Gen. Hugh J. Knerr, is the AAF procurement agency, and it is also responsible for the equitable termination of the contracts. Each war procurement agency terminates its own contracts under policy direction of the Office of Contract Termination.

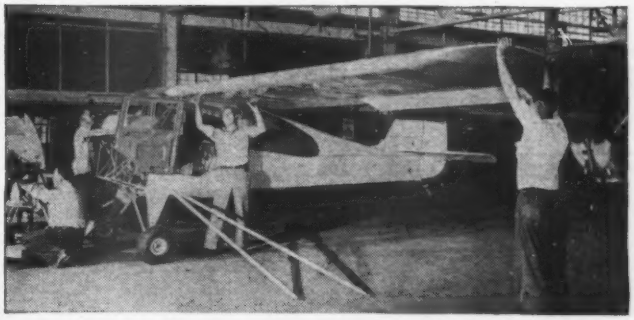
ATSC's Readjustment Div. had already processed 11,076 contract terminations when Japan surrendered, settling 9,042 of them. Average time required for settling fixed-price contract claims has been reduced from about 8 mo. to 3.4 mo.

The work is carried on by specialists in contract termination, at 114 AAF centers throughout the country. Objective is to pay off claims or make loans in amounts due contractors, clear their plants of government-owned tools and equipment, and arrange for the disposition of their surplus property, so that conversion to civilian production may be hastened.

Plant Disposal Problems Cited in Surplus Study

Disposition of aircraft plants, mostly owned by the government, is a major consideration of House and Senate committees studying revision of the Surplus Property Act.

Prime problems in surplus property are: The proposed appointment of a single administrator to supplant the present Surplus Property Board, and how to protect manufacturers of airframes, aircraft engines, propellers, and other war equipment, and at the same time give consumers the benefit of immediate availability of these goods, as well as give taxpayers as much recovery of cost as possible.



THAT POSTWAR WORLD IS HERE

First peacetime Aeronca nears end of assembly line at company's Middletown, Ohio, plant, which until very recently was turning out liaison craft for AAF. This model is tandem-seat Champion mounting 65 hp. engine. Retail price: $2,095.

Several government-owned plants have already been sold to the manufacturers who were operating them under lease. Problem whether to hold aircraft plants in stand-by condition for emergency is a serious one. Some of them are not well located for industrial use. Plants designed for aircraft production are not suitable for many other lines of manufacture.

Aircraft Materials Freed

WPB has exempted surplus aircraft materials, both government and contractor owned, from inventory restrictions, when used in the manufacture of civilian aircraft.

The directive permits manufacturers or aircraft and subassemblies to receive from other such manufacturers and from government owning and disposing agencies, idle, excess, and surplus materials without regard to inventory restrictions. Large surpluses of many materials and components wanted in the production of civilian airplanes are left over from the suddenly-stopped war aircraft program.

CMC Readies Light Engine

Continental's aircraft division is now going ahead with its new Series C horizontally opposed aircooled engines for light planes, reports Pres. C. J. Reese. Further, company is redesigning its I-1430 12-cyl. power plant to obtain more horsepower. It is also stated that Lockheed Saturn feederliners will be equipped with 700-hp. Continentals as standard.

★ FOR THE RECORD ★

Howard Aircraft has purchased Electric Motor Corp. of Racine, Wis., as first step in revitalizing plane-building company.

J. J. Heatley has organized Airline Schedules, Inc., and is producing consolidated airline timetables over routes covered by two or more lines. Nine tables are already out, and additional ones are being planned. All are revised and re-issued each month.

Wilmotte Laboratory, Inc., has opened a branch laboratory at 236 W. 55, New York City, to offer additional service in application of electronics for industrial use. New lab will be under direction of Paul H. Cragc.

Air Associates, Teterboro, N. J., having been named national distributor of aircraft valves and fittings produced by Parker Appliance Co., Cleveland, will stock parts at Teterboro, Atlanta, Chicago, Dallas, and Los Angeles.

U. S. Plywood Corp. has been appointed exclusive distributor for "Decorative Micarta," a laminated plastic sheet manufactured by Westinghouse Electric Corp.

Trane Co., LaCrosse, Wis., is starting an expansion program to more than double present output, on assembly line basis, of heating and air conditioning units.

Lincoln Electric Co. has opened a direct factory branch sales office under direction of B. J. Brugge. Location is 4427 Manchester Ave., St. Louis, Mo.

Northrop - Gaines, Inc., wholly owned subsidiary of Northrop, has been announced as new name for Socal Foundry, Los Angeles. Lightweight aircraft metals and new fabricating techniques will be used to produce materials-handling equipment, also transport toys.

Guy H. Evans, formerly assistant export sales manager for Douglas Aircraft, has opened "Airline Representation," a new service at 6022 Wilshire Blvd., Los Angeles.

Harco Steel Construction Co., has changed name to Harco Tower, Inc.

Bendix International has been organized as new division to handle foreign trade program of Bendix Aviation Corp. It will be headed by Charles T. Zaoral, and headquarters are at company's office at 30 Rockefeller Plaza, New York City.

Industrial Hydraulics Corp., with W. T. Stephens as president and chief engineer and W. B. McClelland as vice-president and sales manager, has opened offices in Cleveland Trust Bank Bldg., Painesville, Ohio. Firm will produce simplified pumps, valves, and cylinders.

Butler Mfg. Co., Kansas City, has acquired all patent and manufacturing rights of Steel Building Div. of Globe-Wernecke Co. Initial experimental buildings are being fabricated prior to tooling for mass production.

★ KNOW-HOWS ★

Rosan Inserts are being used by PAA on Boeing 314 fuel meters to eliminate fuel leaks at connections.

Black Tenite, made by Tennessee Eastman Corp., is used by S. S. White Plastics Div. for making insulated capscrews and nuts for electrical work.

Using color reaction between iron and ortho-penanthroline for determining iron content in aluminum alloys, Ranger Aircraft Engine Div. has reduced test time from 2 hr. to 20 min.

Carrier centrifugal compressors, driven by 13,000 hp. motors at 110,000v., combined with use of Schlieren camera, has enabled Aberdeen Proving Grounds to observe action of bombs falling at speeds up to 1,300 mph.

Automatic change-over of aircraft fuel tanks, giving continuous flow, has been developed by ATSC. New system is reported to have eliminated former risks and difficulties involved in old manual switch-over.

Radic control panel combining communications unit with range receiver, has been developed by Bendix Radio for converting Army Beechcraft UC-45's to civilian flying by CAA beam.

At Douglas, grommets lightly brought together in pneumatic squeezer serve to hold parts of work in place while spot-welding. Full pressure is applied later when fastener is installed.

Taper-checking fixture, which by small clamping arrangement holds tapered parts in a measuring machine, has avoided long mathematical processes at G-E's Pittsfield, Mass., works, with improvements in speed and accuracy.

Automatic stencil holder, using linen instead of paper stencils, is reported by Martin to have saved thousands of hours in marking materials.

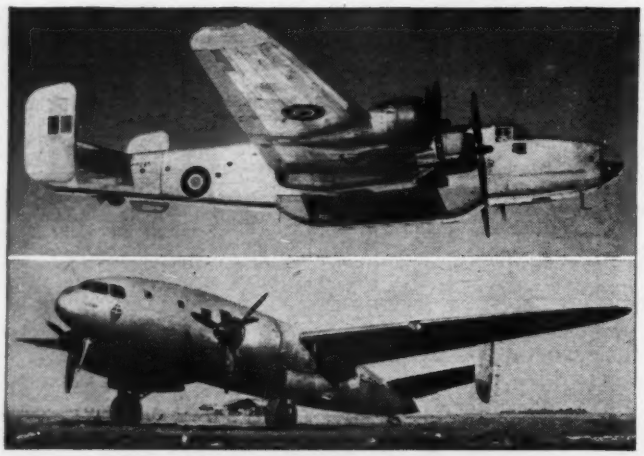
Sensitized plywood, for direct photographing of templates up to 50 sq. ft. in area, are stated by Douglas Fir Plywood Assn. to have saved much time and cost at Boeing aircraft plants.

★ OBITUARY ★

Edward S. Evans, prominent in aviation and president of Evans Products Co. In 1926, he demonstrated practicability of air transport by establishing a round-the-world flight record of less than 29 days, and as director of National Air Transport he was pioneer in air passenger service. He was active in organization of Northwest Airlines, was formerly president of Parks Air College, Curtiss Flying School, and Aircraft Bureau of Detroit Board of Commerce, and also served as chairman of Detroit City Airport Committee. He founded Wayne University's air cargo research activities and the Edward S. Evans Transportation Research. He was Lt. Col., retired, Air Corps Reserve.

Dr. Robert A. Goddard, noted physicist and inventor. Well known for his many years of pioneering in the fields of jet and rocket propulsion, his wide knowledge of subjects was drawn upon by government during late war.

Joe Parker, chief test pilot, Republic Aviation Corp. He served 9 yr. with AAF, and instructed fighter pilots in flight problems of compressibility and range.



BRITISH AND FRENCH WAR-BABY AIRLINERS

Here (top) is commercial transport version of Handley Page Halifax bomber intended for immediate postwar use. Stripped of military equipment, craft is designed to carry 11 passengers and crew of 5. Bulge under fuselage is a detachable, 8,000-lb. capacity freight pannier which can be let down by winches and replaced by another loaded container, thus allowing rapid handling. Fitted with four 1,650-hp. Bristol Hercules engines, craft's range is given as over 2,000 mi. (British Information Services photo)

Above: First of its type to be built in France, this SO-30N Bellatrix airliner was designed for substratosphere travel. Weighing 12 tons, craft is stated to have 300-mph. top speed, to cruise at 257 mph., and to have a range of 1,250 mi. Power plants are 1,260-hp. Gnome-Rhones, and seating capacity is given as 23 passengers and crew of 4. Bellatrix was designed and built under noses of Nazis and hidden until liberation. (French Press & Information Service photo)

WORLDATA . . . . . By "VISTA"

A curious situation has developed in Mexico, where a full-fledged battle has developed between CMA, Pan American subsidiary, and Aerovias Braniff, offshoot of the Braniff system in this country. Argument started when Braniff inaugurated service between Mexico City and Laredo, duplicating one of CMA's more prosperous routes. Then, in July, Braniff opened service to Merida via Puebla and Vera Cruz, again bedding in beside a CMA main run. All angles of the argument are not available, but it is known that attempts were made to keep Braniff equipment and personnel off airports owned by CMA. Supposed cause for this action was Braniff's refusal to pay an 85 *peso* fee (about $17) per landing, but it is generally felt this is not the only reason—repercussions were too many to have sprung from just a minor argument over landing charges.

Shortly after Braniff inaugurated Merida service, the Ministry of Communications cancelled its permit for that run. Braniff promptly obtained a court injunction and continued service. Late in August this injunction was made permanent. Immediately following this, Gen. Alfredo Lezama, chief of civil aviation in Mexico, resigned, and inside reports from Mexico City state that his favorable attitude toward Braniff and other new companies was the immediate cause for his departure. Little is known about the political sympathies of the Minister of Communications, and it is therefore hard to predict what the next development in the Mexican situation will be. It is quite obvious however, that the battle foreseen in AVIATION (July, page 183) is now well started.

KLM is apparently leaving no stone unturned to regain its prominent position in international air transport. Large orders for modern type equipment from both Lockheed and Consolidated Vultee are rumored, and the continued presence of both Managing Director Plesman and his assistant Veenendaal in this country supports information that much of the company's equipment will again come from the U. S. Negotiations are now under way for routes both to the Atlantic and Pacific coasts, and a South Atlantic route to Curacao is expected to be inaugurated in 1947.

The Australian situation is still confused concerning the airline nationalization bill, and considerable opposition has already come from many quarters. Most-attacked feature of the bill is the limitation of authority of the airline board to pay anyone more than $4,850, spend more than $32,500 abroad, or buy or sell assets of more than $16,250 value without approval of the minister. It is felt this provision would make the airline a political instrument, with the best jobs and biggest contracts subject to the minister's office. Meanwhile the Australian Government is spending nearly $5,000,000 for new airports at Sydney, Melbourne, and Adelaide.

★INTERNATIONAL BRIEFS★

ENGLAND — Both BOAC and Swedish ABA have shifted operations to Croydon airport, which is being reconditioned for airline service, pending decision on a new London facility.

It has been stated in Parliament that 20 Avro Tudor I's have been ordered for trans-Atlantic service, while a large number of Tudor II's have been ordered. First Tudor II will fly next month, and production will be under way by Jan. 1946.

Initial Handley Page Hermes will fly this month, but no orders have yet been placed for this plane.

Some importance is attached to appointment of Air Vice Marshal Bennett as operations manager for British Latin American Airways in view of his experience with BOAC.

Passenger service to Channel Islands has been reopened with familiar de Havilland biplanes used before war.

RAF losses in European war totaled 16,285 planes, of which Bomber Command lost 9,163, Fighter Command 3,558, Second Tactical Air Force (Mediterranean) 2,115, Coastal Command 1,479, and Army Cooperative Command 70.

Civil version of Short Sunderland flying boat, called the Sandringham, is now in production. Accommodating 24 day or 16 night passengers, plane weighs 56,000 lb. and cruises at 199 mph. with a 1,600-mi. range.

FRANCE — Unconventional fighter is new VB-10, with pilot sitting between two Hispano engines, driving contra-rotating propellers in nose. Plane, built in secret during occupation, has a top speed of 435 mph. with a total of 2,500 hp.

While internal air services are still on a small scale, most French colonies are now interconnected and have air routes to Paris.

SWEDEN—ABA has started service to Netherlands again, after completion of preliminary repairs at Schiphol airdrome, Amsterdam.

FINLAND—Finnish Air Force is seeking a substantial number of Myrsky fighters, which would be built in Finland. With a 1,160-hp. Twin Wasp, plane is estimated to have a 300-mph. top speed. It is armed with four machine guns.

USSR—Among air services currently connecting Moscow with other European cities are those to Vienna, Budapest, Warsaw, Prague, Sofia, Belgrade, and Teheran.

SWITZERLAND — Swissair reopened service to Paris via Geneva from Zurich, and it shortly hopes to extend to London. Service to Sweden via Holland is also expected shortly.

Switzerland and U. S. have signed a bilateral air pact, giving Swissair landing rights in New York. This company is negotiating for American aircraft, and its president, Henry Pillichody, will shortly return to this country to make arrangements for new service.

ARGENTINA—Reports indicate that Argentine airlines have placed orders in Britain totaling $12,500,000 for aircraft and equipment.

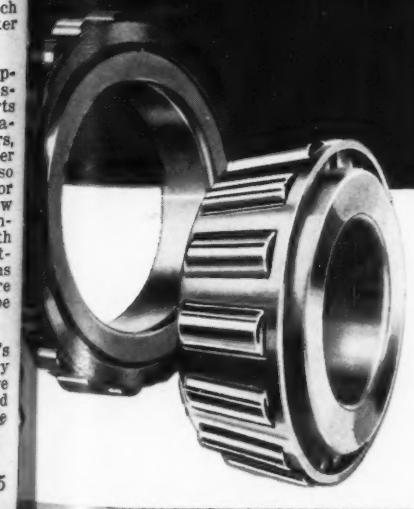
A firm of ship owners in Buenos Aires has purchased four Short Sunderlands from Britain. Planes have been converted to carry 30 passengers.

CHILE—This country's national airline, LAN, has been offered British equipment, in competition with American offers. Quoted prices are substantially lower for equipment of similar performance.

CUBA—Planes and equipment are now being purchased by Maj. Ardois for his newly organized Cuban Air Lines, which will provide a taxi and charter service throughout Republic.

AUSTRALIA—Since its inception, Australian aircraft industry has produced 700 Beauforts and Beaufighters, 700 Wirraways, 200 Wackett Trainers, 250 Boomerangs, 1,070 Tiger Moths, and 87 DH-84's. Also built were 1,300 Gipsy Major power plants, also 850 twin-row and 700 single-row Wasp engines. At end of war, North American Mustangs, also British Mosquitos and Lincolns were in production, as were Merlin engines. Tudors will be built shortly.

JAPAN — Discovered at war's end was Rita, four engine heavy bomber powered with Homare 2,000-hp. engines. Craft had tricycle landing gear and single fin and rudder.



INTO THE FUTURE . . .

In the peacetime days ahead, new and better automobiles, aircraft, motor trucks, tractors and a host of other modern machines will be supplied with ever-increasing numbers of newer and still better Bower Roller Bearings.

BOWER
ROLLER BEARING CO.
Detroit 14, Michigan

Weekend in Honolulu? *Let's go!*

No fanciful dream on a designer's drawing board is this huge six-engined Clipper. Months ago Pan American placed an order with Consolidated Vultee for a fleet of these sky-giants . . . soon they will become an actuality.

204 passengers and 7 tons of mail and freight will speed non-stop across the North Atlantic to Europe. Daily service to Honolulu and Latin America is part of Pan American's sweeping postwar plan to bring distant places closer than they have ever been before.

These are the types of planes for which Chandler-Evans builds carburetors and fuel pumps. The larger planes — with engines from 400 H.P. up to the big ones needed by this new sky giant — demand the engineering precision and dependability that is built into every CECO product. As it is serving the Liberators, Superfortresses, and other big war planes today, so will Chandler-Evans supply tomorrow's greatest air liners.

CECO

CARBURETORS
FUEL PUMPS
PROTEK-PLUGS

ARMY NAVY

CHANDLER-EVANS CORPORATION SOUTH MERIDEN CONNECTICUT, U.S.A.

Examiners Advise Broad N-S Expansion; No Threat Yet Seen to Regular Carriers

. . . See "break" for NWA in Pacific report . . . Deny petition to reopen North Atlantic case . . . Report on Interim Council; Warner is president . . . Compromise mail rate posed by CAB

More freedom for expansion of non-scheduled air transport is recommended in a report to CAB by Examiners William J. Madden and Curtis C. Henderson. The report suggests that no economic control be imposed upon non-scheduled carriers, except a limitation of ten trips a month between points served by certificated operators.

The examiners advise that the distinction between scheduled and non-scheduled operators be dropped and that the latter be permitted to set up fixed schedules of any desired frequency, without certification, so long as points served do not have certificated airline connections.

In recent years the certificated airlines have feared eventual harm from non-scheduled competition. It is the policy of the government that its certificated airline system, on which it depends for carriage of the airmail and for special services in emergency, shall not be subjected to damaging competition.

Therefore the examiners have sought to revise the legal clause that exempts non-scheduled operations from regulation, to the effect: (1) That statistics on such operations may be available in future; (2) that unauthorized services may be prohibited by requiring non-scheduled operators to have operating certificates from CAA (not to be confused with certificates of convenience and necessity issued by the Board); and (3) that freedom of expansion may be permitted, aiming for maximum employment and for the benefit of the public.

The non-scheduled question demands early solution because returning service men want to engage in the business, because of the airplane shortage, and because an increasingly airminded public will want to travel off-airlines. Examiners found no immediate need for action on air cargo and charter services, which they said are very small. They added that non-scheduled services are not as yet a threat to the certificated airlines.

This report is merely a recommendation to the Board, which can differ with examiners and make partially or wholly adverse decisions. The Board will consider the increasing local pressure for short airlines. CAB Chairman L. Welch Pogue long ago expressed opinion that uncertificated services should have shortline business on a trial basis, and later might be certificated.

The Board is up against a problem of compromises, for a period of time, between the established airlines and the non-scheduled lines. If the latter succeed in operating on regular schedules their very name will be a misnomer, and there will be no reason why the public should not demand mail service on them. In that case there would be no essential difference between the two. Unofficial opinion is that eventually there will be no distinction, and both will be subject to the same restrictions and privileges.

See "Break" for NWA In Pacific Report

CAB examiners, reporting on the "Pacific Case," last of the Board's five subdivisions of foreign service route proposals to come up for hearing, make nine specific recommendations which the Board is likely to accept, if it follows precedent:

1. That a certificate for 7 yr. service be issued to Northwest Airlines between New York-Chicago and Manila, P. I., via Alaska, Tokyo, Shanghai, and Hong Kong.

2. That Pan American's certificate be amended authorizing operations, limited to 7 yr., between Midway and Calcutta via Tokyo, Shanghai, Hong Kong, and Bangkok; and between Manila and Batavia, Java, via Singapore.

3. That PAA provide nonstop service between Honolulu and Wake.

4. That PAA provide service between Noumea, New Caledonia, and Sydney, Australia.

5. That Alaska Airlines operate service between Anchorage and Seattle, but shall not carry traffic between several intermediate points.

6, 7, 8, 9. That certain minor changes be made in the certificates of PAA and Western Airlines' Canadian and Alaskan airline service certificates.

If the Board issues orders in accordance with the examiners findings, Northwest Airlines, which for years was regarded as a minor airline member, will become one of the world's major operators, and the long-contemplated "over-the-top" route to the East will be realized. A certificate for Northwest to the East, like all other foreign-service authorizations, would have to be approved by the President. It is more than likely that another route will be authorized through Alaska to Russia, and that the Russians will ask for entry to the United States via the North.

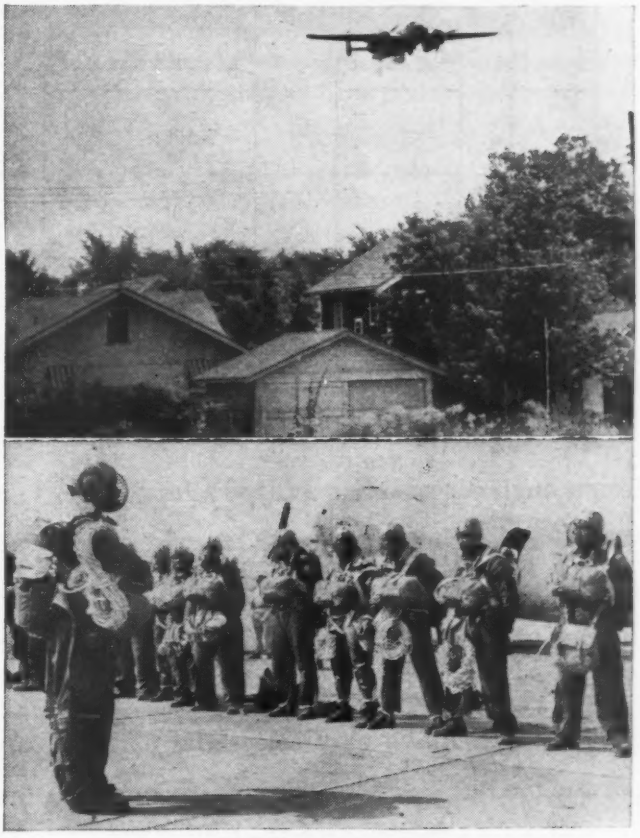
Deny Petition to Reopen North Atlantic Case

In a terse order less than two pages long, CAB declined to reopen the "North Atlantic Case" in response to a petition by Pan American Airways, Penn-Central, Moore-McCormack Lines, and Northeast Airlines.

Pan American in its petition had charged that the Board, in awarding trans-Atlantic routes to American Airlines System and to TWA, and granting European extensions to PAA, had placed the latter at a disadvantage especially with regard to terminals on the Continent. The Board denied it had shown "gross favoritism" to TWA, denied that legal notice of hearing was inadequate, and concluded that findings in the petition do not justify reargument.

Report on Interim Council; Warner Is President

Meetings of the Interim Council of the Provisional International Civil Aviation Organization (PICAO) closed at Montreal with satisfactory ac-



HERE'S QUICK RECONVERSION

Both AAF men and planes demonstrate speedy transition from roles of destruction to those of conservation. Top photo: North American B-25, specially rigged by ATSC, sprays DDT over polio-stricken Rockford, Ill., in experiment to determine efficiency of famed new insecticide in combatting spread of disease.

Above: Jumpmaster briefs Negro paratroopers at Pendleton, Ore., Air Base, prior to timberland fire-fighting mission via Troop Carrier Command Douglas C-47. Men are 'chuted to otherwise inaccessible blaze spots to nip flames before damage can mount. Besides considerable equipment each man carries, there are supplementary chutes for dropping such heavier tools as axes, shovels, and water pumps. (Press Assn. and Wide World photos)

DESIGN ADVANTAGES

in overall size and capacity...

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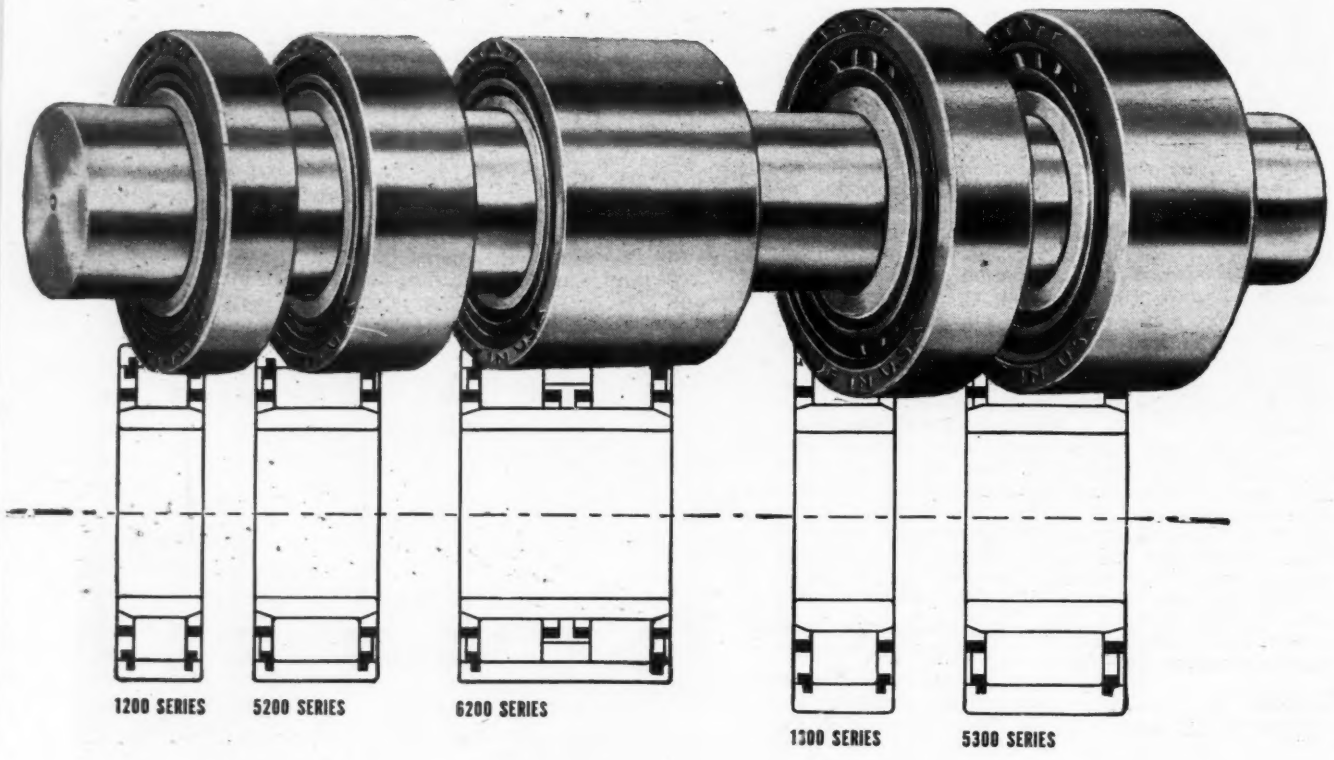

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If the load is light he may select the narrow width of the medium series—gaining in economy of cost, weight and space. If loads are heavy and the permissible outside diameter is limited, there are the wide and duplex widths of this same series. If loads are heavy and axial space is not available, the narrow and wide widths of the medium series provide increased capacity by increasing the annulus size.

These five combinations are available for most of the standard bearing bore sizes. All are manufactured from the same select materials and with the same precision to provide quiet, care-free operation. Ask for our Hy-Load Bearing Bulletin.

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cord having been reached by the representatives of 19 countries participating. The Council was scheduled to meet again Oct. 15.

Edward P. Warner (pictured page 225), former Editor of AVIATION, and for the past several years vice-chairman of the Civil Aeronautics Board, was elected president of the Interim Council. He is recognized here and abroad as a foremost authority on aircraft design and operation, and on aeronautics administration. He was succeeded as American delegate to the Council by Col. Gerald Brophy, former chief, AAF international branch.

Work on the Council's technical problems begin Oct. 2 and 3 with meetings of the Air Navigation Committee and the Air Transport Committee, respectively.

Dr. Albert Roper, of France, for 23 yr. secretary of the International Commission on Air Navigation, was unanimously elected to the secretaryship of PICAO. ICAN will be disbanded by steps, as the Council takes over and the Chicago convention comes into force.

Compromise Mail Rate Posed by CAB

Last Jan. 1, CAB ordered the "Big Four," airlines (American, Eastern, Transcontinental, and United) to show cause why their mail rates should not be reduced from 60c. to 32c. per ton-mile, a cut of almost 50%.

Now, as expected, the Board has compromised by suggesting a rate of 45c. per ton-mile, which it believes will be adequate to meet the imminent procurement of new equipment and to tide any over fluctuations in passenger revenues.

The Board's recommendation is contained in amendments of tentative findings during rate investigations, and in amendments to the show-cause orders previously served.

These lines, and others, meanwhile had reduced their passenger fares an average of 7½ percent to 4.5c. per mile, effective Aug. 20. It was believed, and generally predicted, that the Board would modify its call for a drastic mail pay cut if the airlines would give the traveling public the benefit of high war earnings by cutting travel fares.

★ CROSS COUNTRY ★

TACA opened a new route to South America linking Costa Rica . . . Airline acquired four more Lockheed airliners, bringing total number of craft operated by company in Central and South America to 52.

EAL's N. Y.-Washington service was stepped up with addition of four new daily round-trip flights . . . Airline now operates 23 daily passenger flights between these two cities, plus four cargo services.

National Skyway Freight Corp. is new contract non-schedule air freight service, with former members of famed Flying Tigers and India-China "Hump" airline as owners and operators. With hq. at Long Beach Municipal Airport, company will use seven Budd RB-1 Conestoga cargo craft on West Coast runs. Cargo carrying contracts are now being negotiated.

PAA is operating Lockheed C-69 Constellations on coast-to-coast non-stop schedules for ATC, and has discontinued its AAF twin-engine operations. Company-operated C-69 recently was reported in record Washington-Burbank flight of 8 hr. 44 min, flying at 50 per cent power at 12,000 to 14,000 ft., averaging 272 mph. for 2,350 mi. . . . Airline inaugurated three more flights between Barranquilla, Columbia, and Cienaga, Sierra Nevada de Santa Marta.

Delta Airlines received CAB permission to establish a direct route between Miami and Chicago via Cincinnati.

NAL received CAB authority to add New Bern, S. C., as an additional stop on its route between Miami and N. Y.

AA added an extra daily round trip between N. Y. and Los Angeles, bringing total of coast-to-coast flights to 24 daily. New flight will include stops at Washington, Nashville, Tulsa, Oklahoma City, and Phoenix . . . Company's Baltimore service has been resumed, with five flights now calling at this city daily.

★ CALLING NAMES ★

(*Continued from page* 209)

Charles L. "Les" Morris has been named asst. to pres. of Bendix Helicopters.

Jack Cornelius has been named v.-p. in charge of maintenance for National Skyway Freight Corp.

R. S. Huested became administrative asst. to v.-p. and general mgr. of Wright Aero.

Frank E. Loomis has been named EAL's city mgr. for Charleston.

Kenneth C. Gunter has been appointed PAA's advertising mgr.

Benjamin F. Pepper became chairman of TACA Airways, S. A., board of directors, and **John D. Warren** has been named to board.

W. E. Kline is new CAA acting regional administrator for first region with hq. in N. Y. C.

W. R. Hall has been named mgr. of U. S. Aviation Underwriters western dept.

William E. Cullinan, Jr., became director of Bureau of Aviation of N. Y. State Commerce Dept.

E. S. Stafford is new head of Beech Aircraft's export sales dept., and **W. Homer Kelly** has been named public relations director.

Joseph D. Boylan has been made AA's general Airfreight agent, and **Richard W. Baker** is new district traffic mgr. in Phila.

Gabriel R. Volgiotti, formerly with PAA, joined Jordanoff as director of business research and is in charge of advertising and public relations.

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• For engineering help with your product problems, call Carpenter. And for printed information, ask for the data file folder on Carpenter Welded Stainless Tubing. It will point the way to lower costs ... improved product performance.

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SIZES . . . . 3/8" to 4½" O. D.

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SHAPES . . . Round, half-round, oval, flat oval, perforated, shrouded, open seam, butted, D-shape.

FINISHES . . White pickled with standard grits. Also inside and outside polished.

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We are ready *now* to fill industry's peacetime needs.

Revere hopes that, in the conflict just ended, what we won was the gigantic opening battle for better living. To fight *this* war our nation needs materials and the products of industry on a scale even greater than that which won military victory.

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With all these enhanced resources we are ready now to serve man's creative spirit and, by supplying industry in abundance, to help make of life the rich, joyous thing it can be.

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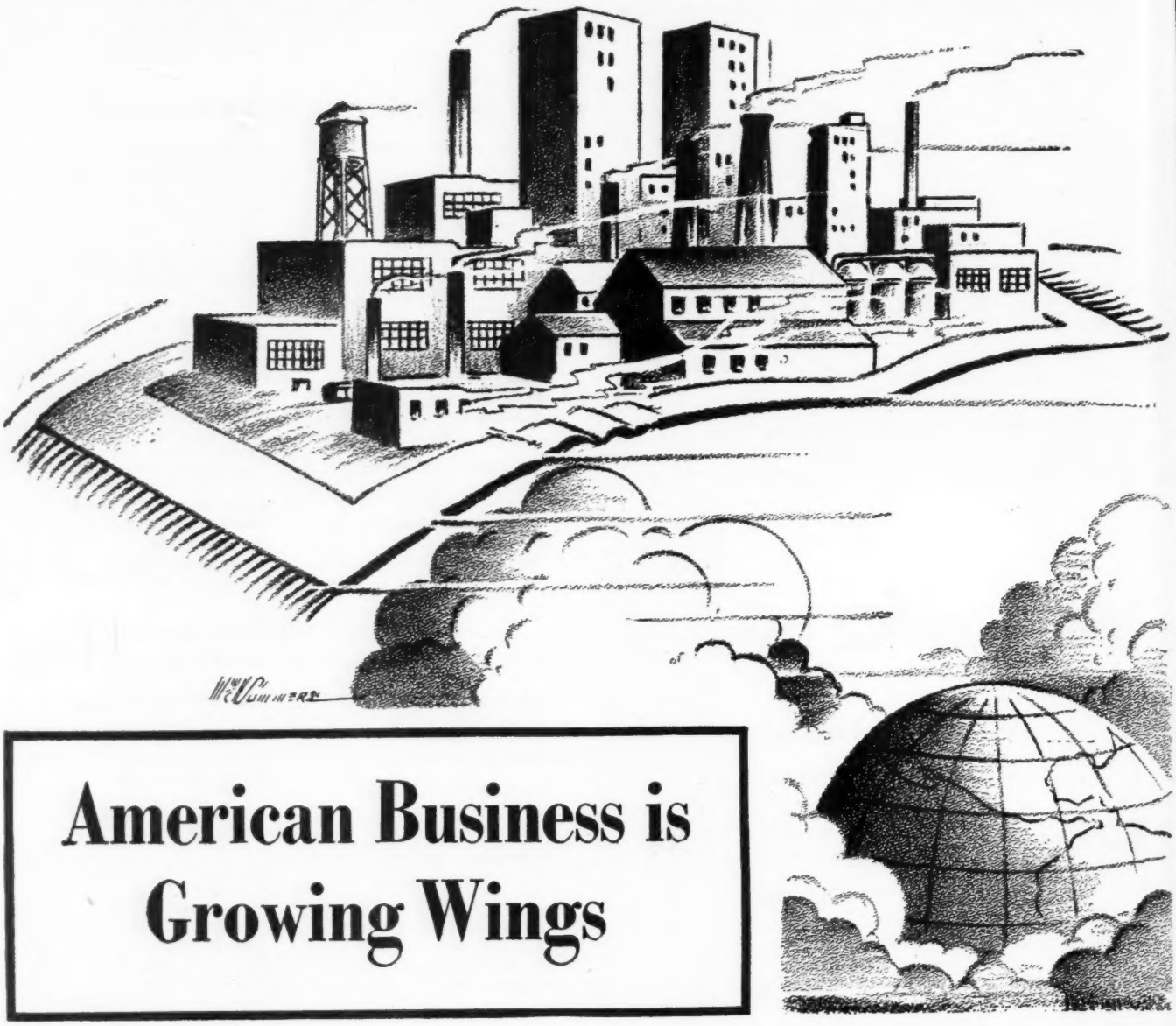
This is the third in a series of advertisements concerning the future of Aviation . . . in America



American Business is Growing Wings

MAKING America strong in the air, and thereby assuring National Security, is a program which will have the wholehearted cooperation of American Business as well as the support of John Q. Citizen, Government, and the Aircraft Industry. And American Business, giving this support, will of course gain many benefits from the conversion of our increasing aviation skills and capacities to the ways of peace.

Just as aviation has helped to solve the problems of logistics in wartime, so will aviation provide industry and business with new tools for shrinking the distance between markets, for opening new channels of distribution, and for achieving quick and ready access to any part of the world in a matter of hours.

As industry takes advantage of the facilities offered by aviation in the days ahead, it will thereby contribute to the further development of aeronautical science in America—for example, by using such new aircraft as the helicopter on many assignments for which this craft is especially adaptable and useful.

For these and many other reasons, American Business will do its part to make our Nation a great peacetime air power, working for Security and Permanent Peace.

At Bell Aircraft, we shall continue to utilize the ingenuity and research that helped to develop many of our victorious aerial weapons to establish aviation and air power as a partner in progress to Business and to all mankind.

★ *Buy War Bonds and Speed Victory* ★

MEMBER AIRCRAFT WAR PRODUCTION COUNCIL...EAST COAST, INC.

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Bell Built B-29 Superfortress

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United Aircraft Corp. reports net profits for first half of '45 were $6,957,950, or $2.37 a share, compared with net profits of $8,450,113 or $2.93 a share in like '44 period. Sales were $332,821,621 against the $421,444,094 a year ago.

Republic reports estimated net income of $1,550,000 equal to $1.57 a share for the six months ended June 30. Out of net, Pres. Marchev reported, $436,000 has been set aside for postwar readjustments. Sales for period were approximately $148,000,000.

Northrop announced a backlog mounting up to $2,000,000 monthly through Aug. 1947. Company's experimental research and development programs are "virtually untouched" by ending of war.

Backlogs: Solar has received war contract cancellations amounting to around 60% of its $40,000,000 military backlog as of Aug. 1 . . . Fairchild Camera & Instrument has military contracts totaling $11,000,000, following V-J day cancellations . . . Menasco retained war contracts of $7,000,000 following cancellations.

Beech will continue development work in Derby, Kan., area in an effort to uncover additional gas reserves. Company is now operating three wells which provide an output of more than 2,500,000 cu. ft. daily.

Bendix Aviation plans to produce bicycles at a rate of more than $2,000,000 annually . . . Martin has experimental orders for aluminum castings designed to preserve ordnance in firing condition and ready for instant use in any future national emergency.

American Airlines reports net earnings of $2,311,066 or $1.79 a share for the six months ended June 30 against net profits of $2,165,035 or $1.68 a share in like '44 period. Gross was $21,769,374 against $16,791,172 a year ago.

Braniff Airways reports net profits of $129,866 or 13¢ a share for quarter ended June 30 compared with net profits of $392,285 or 39¢ a share in like '44 period. Total revenues were $2,006,406 against $1,562,784 a year ago.

Continental Air Lines reports net profit of $348,237 or $1.30 a share in fiscal year ended in June against net profits of $199,410 or 77¢ a share in previous fiscal year.

Eastern Air Lines reports net profits of $856,787 or $1.44 a share for six months ended June 30 against net profits of $438,413 or 73¢ a share in like '44 period. Operating revenues for six months increased 53% to $12,323,642.

TWA reports net profits of $1,699,163 or $1.73 a share for six months ended June 30 against net profits of $666,253 or 68¢ a share in the like '44 period. Gross was $17,218,608 against gross of $10,490,785 a year ago.

United Air Lines reports net profits of $3,541,785 or $2.20 a common share for six months ended June 30 against net profits of $2,924,837 or $1.79 a share in like '44 period.

Western Air Lines reports net profits of $266,350 or 65¢ a share for six months ended June 30 against net profits of $43,233 or 10¢ a share in like '44 period. Gross was $3,355,762 against $1,526,990 a year ago.

Bell Aircraft reports sales for first half of '45 of $177,000,000. After provision for taxes of $9,600,000, net income was approximately $3,900,000 before contingency reserves.

National Aviation Corp. reports indicated value of net assets on June 30 of $10,422,763 or $23.34 a share against $8,497,980 or $19.03 a share on Dec. 31, 1944.

Thompson Products reports net profits of $1,232,356 compared with net profits of $1,546,030 in like '44 period. Net sales were 62,690,621 against $68,411,859 a year ago.

Square D Co. reports net profits of $922,870 or $2.09 a share for six months ended June 30 against net profits of $920,854 or $2.09 in like '44 period. Net sales were $21,747,868 against $22,243,024 a year ago.

War Contracts Still On Books

Continuing military contracts of 14 of prime aircraft producers total $1,431,809,000, as shown below—giving grand sum of well over $1,500,000,000 for nation's aero industry.

Aviation Corp.	$3,647,000
Beech	6,965,000
Bell	34,000,000
Boeing	222,630,000
Consolidated	260,000,000
Douglas	175,000,000
Fairchild	84,000,000
Grumman	141,000,000
Lockheed	151,000,000
Martin	190,000,000
Northrop	62,567,000
Republic	37,000,000
Ryan	27,000,000
Solar	16,000,000
	$1,431,809,000

ADDING IT UP . . . . . By RAY HOADLEY

Unfilled Orders. It was in July of 1940 that unfilled orders of the aircraft industry topped the $1,000,000,000 mark for the first time. Today, military contracts remaining on the books of 14 of the prime aircraft producers amount to $1,431,809,000, as shown by the list tabulated elsewhere on this page. Thus at the first blush of reconversion the industry emerges with a backlog of more than $1,500,000,000 to carry it through the next 18 mo., as far as government work is concerned. And more will be added, possibly another billion dollars or so, unless Congress shies away from making the necessary appropriations available for experiment, development, and new-model production.

Contrast to 1939. Just how well the industry as a whole has fared in the initial stage of reconversion may be seen from the fact that its 1939 volume (including a large amount of British and French business) totaled only $278,000,000. Right now Douglas and Lockheed together have more than that amount of commercial transport business on their books.

Engine Companies. Backlogs of Curtiss-Wright and United Aircraft are not included in the compilation of the 14 companies. Both companies continue to hold engine, plane, and propeller contracts from the government in substantial volume. Even so, it would appear that these integrated companies which produced an aggregate of nearly $2,500,000,000 of aircraft last year, will be among the hardest hit, relatively speaking, in the industry. Certainly, the surplus disposal problem will be tougher for them than for most others.

Stock Market. Wall Street took the cancellation of billions of dollars of aircraft war contracts more or less without batting an eye. All things considered, the aircraft stocks put in a very credible performance throughout the confusion attendant upon the end of the war. What selling there was of aircraft shares was concentrated largely in Curtiss-Wright and in United Aircraft common, the only air stocks to sell down, during August, to new low ground for the year.

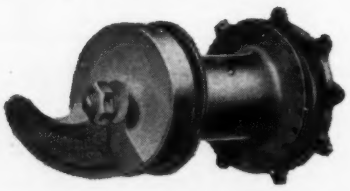
Profit Margins. Aircraft makers, at this writing, are not ready to hazard a guess yet on the profit outlook for the remainder of their military business. With smaller numbers of planes being produced, it is expected that unit prices are likely to go up. And the fact that most subcontracts have been cancelled should prove an aid in bolstering profit margins.

Lifting Controls. The aircraft industry is now completely free of WPB controls, the first war industry to achieve this status.

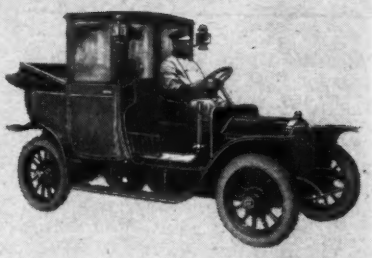
Airline Earnings. As expected, profits chalked up by the domestic airlines for the first half of 1945 established new high records in reflection of continuous wartime traffic gains. However, a word of explanation is needed. The CAB has recommended that the airmail rate for the "Big Four" be cut to 45¢ per ton-mile instead of the 32¢ previously proposed and the 60¢ rate now prevailing. If the rate as proposed goes into effect, retroactive to Jan. 1, current earnings statements would have to be revised quite substantially. American and Eastern, for example, have been accruing mail pay on a 32¢ basis. Their earnings would be larger than reported. On the other hand, TWA and United, which have been accruing mail pay at the present 60¢ rate, would show declines.

Profit Adjustments. Effect of the proposed airmail rate cut would be to increase American's six months' net from $1.79 a share, as reported, to $2.21, while Eastern's profits would edge up from $1.45 a share to $1.62 a share. At the same time the profits of TWA for the six months would slide from $1.73 down to $1.05 while those of United would slump from $2.40 a share to $1.80 a share, on an adjusted basis.

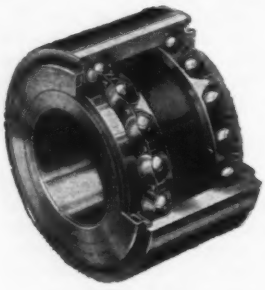
FAMOUS "FIRSTS" by NEW DEPARTURE



First Bicycle Coaster Brake

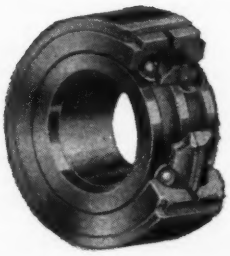


First Yellow Taxicab



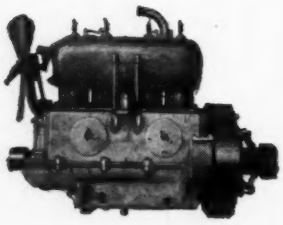
First Self-Sealed Lubricated-for-Life Mine Car Bearing

First Conveyor Roll Bearing



First Dual-Purpose Ball Bearing

First Self-Sealed Bearing Lubricated-for-Life

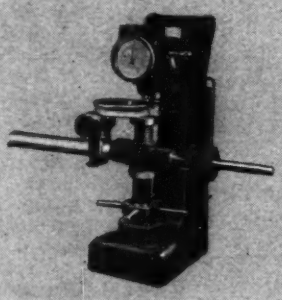


First Engine with Cylinders Cast en Bloc

First Successful Treadle Roll Bearing for Textile Looms

First Fan and Pump Shaft Bearing Self-Sealed and Lubricated-for-Life

3295



Rockwell Hardness Tester

The name New Departure aptly describes an organization whose thought and action has ever been in advance of its time.

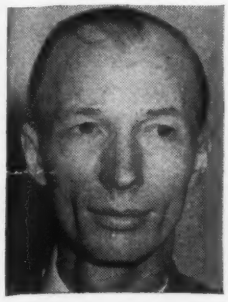
A partial record of the "new departures by New Departure" is reported on this page.

Well over 300 million New Departure ball bearings are in this war, and we will stay with this task until the job is done.

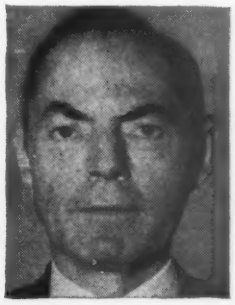
Your future use of ball bearings might well take advantage of New Departure's creative engineering.

Nothing Rolls Like a Ball

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT • DETROIT • CHICAGO • LOS ANGELES



ROY K. BROWN has been made NEA's supt. of maintenance. He came to airline from Wright, and previously had been in charge of maintenance on EAL's N. Y.-South div., and factory representative at Douglas and Lockheed in construction of DC-2s, DC-3s, and Lockheed transports purchased by that airline.



COMDR. JOHN J. IDE, USNR, has been made Asst. Naval Air Attache at U. S. Embassy in London. He was European Representative of NACA at Embassy in Paris from 1919 to 1940, and was then called to active duty with Navy Bureau of Aero and since 1943 has seen service in European Theater of Operations.

ROBERT K. BROWN has been appointed mgr. of C-W's Washington office. Formerly mgr. of contract and service dept. of Cincinnati plant, he joined corp. in 1931, serving in Paterson production dept. as sales engineer. An Annapolis graduate, he joined Wright Aero in 1940 in production dept.

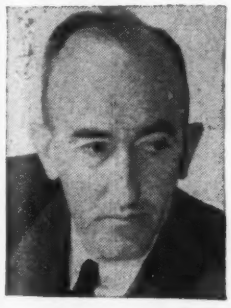
EDWARD P. WARNER has been elected to presidency of Interim Council of Provisional Civil Aviation Organization, and he has now resigned vice-chairmanship of CAB to assume new duties. He was editor of "AVIATION" from 1929-34. He has been closely connected with aviation since 1910.

JOHN E. CREGIER, JR., formerly of Convair, has been appointed sales-service mgr. for Commonwealth Aircraft, and he will supervise all sales promotion for Trimmer amphibian. He has been associated with industry and airlines for over 15 yr. and has had much experience in sales-service and engineering activities.

CARL R. ANDERSON has been named vice-pres. in charge of all J. P. Riddle's domestic activities. First connected with company in 1929, he stayed with AA when latter took over organization in Cincinnati, went to PAA, and then joined Emby-Riddle of Miami as asst. vice-pres. **LT. COL. ARTHUR E. BOUDREAU** has been appointed director of training. Now on terminal leave from AAF, he activated AAF college training program in 1942, later had charge of CAP pre-flight training and commanded units in AAF.

W. D. HOLMAN has been appointed new material chief of Convair's Fort Worth div. His new position will entail obtaining materials for production of company's new giant B-36 six-engine pusher 320-ft. span heavy bomber.

LT. COL. JOHN H. CLEMSON has been released by Army to become general mgr. of midwest region of TWA. He had been general traffic mgr. of airline when he left to enter service as Capt. and became chief, domestic div., priorities and traffic of ATC, directing policy for priorities for all U. S. airlines through 20 regional offices in key cities. **J. A. THOMAS** became executive asst. to transportation vice-pres., with hq. in Kansas City. He has been airline's midwest region transportation mgr. since 1944.



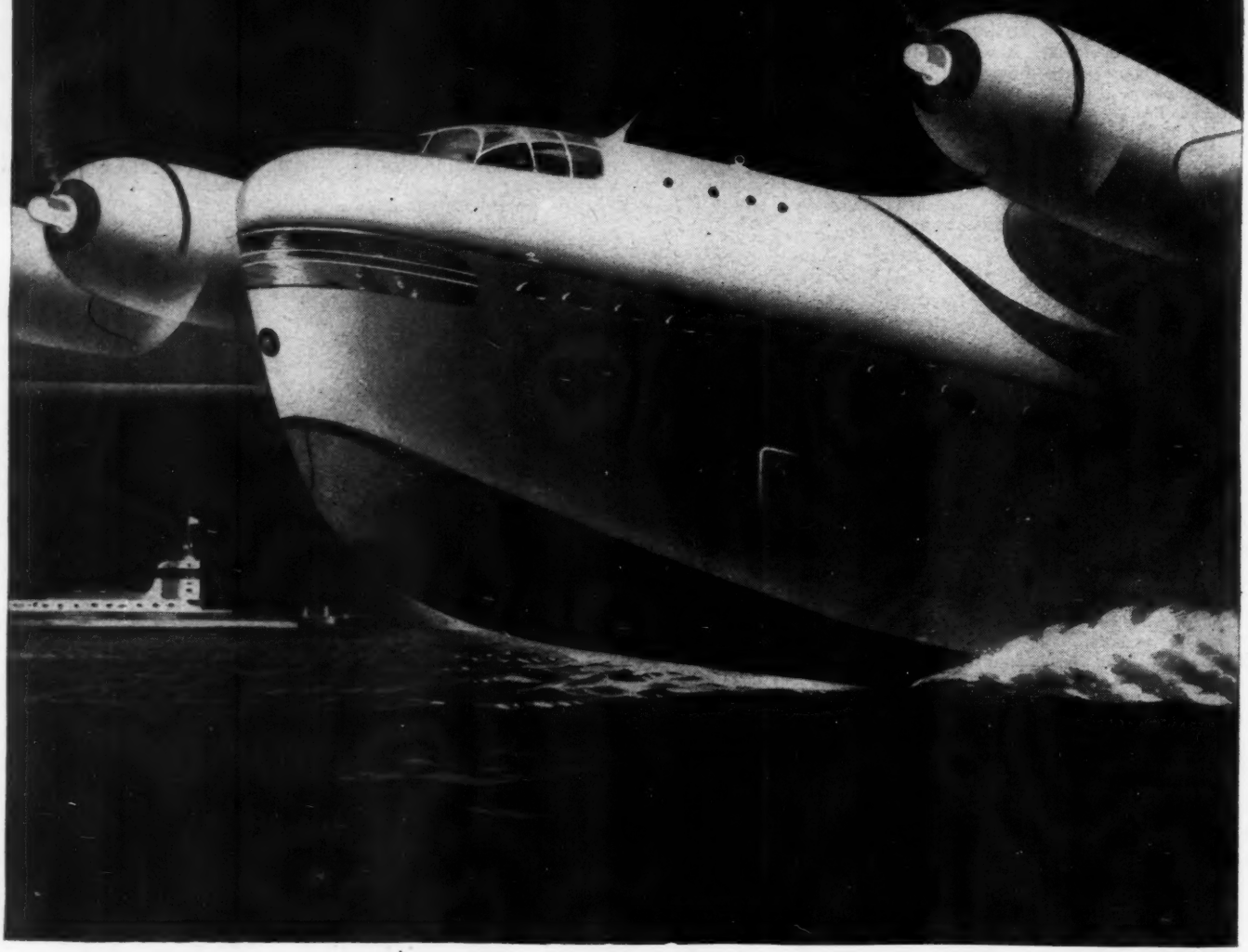
WILLIAM M. ALLEN (left) has been elected pres. of Boeing. For 14 yr. a company director, he became member of board in '31, and previously, on formation of Boeing Air Transport and its purchase of Pacific Air Transport, he served as counsel and board member of those concerns. He received bachelor of arts degree from University of Montana and is graduate of Harvard Law School. **WELLWOOD E. BEALL**, company vice-pres., engineering, was elected chairman of newly-created executive board of aircraft technical committee of AIA. Mr. Beall and five-man board will function as steering committee.

DR. SHAO WEN YUAN has joined staff of Polytechnic Institute of Brooklyn to continue helicopter research and introduce first academic course on rotary wing craft in regular curriculum of an engineering institute in U. S. He had been with McDonnell and is also doing some work for Edo.

GEORGE R. HILL became director of market and sales research for CAL and will develop company's program of passenger and cargo service. He holds a master's degree in business administration from U. of Denver. He was formerly with CIO and OPA. He holds a degree in business administration.

FRANCIS D. MILLER has been appointed to AA's newly created position of director of sales training and will develop refresher courses for company's returning veterans. A graduate of Culver, also Brown University, he had been in Navy since 1942. (Bachrach photo)

The dependability of molybdenum steels has been thoroughly established by their performance in aircraft engines.



CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

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NEW PRODUCTS

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This selected information on new publications and products is offered by the "AVIATION" Reader's Service through cooperation with the manufacturers. It helps executives save valuable time, provides profits through convenience. To obtain literature or additional data on new products described, simply fill in form below, clip it to your letterhead, and mail. There is no cost, no obligation.

ENGINEERING DATA

Detonation Indicator 1

Details of M. I. T.-Sperry detonation indicator for aircraft engines, with specifications and engineering drawings, are contained in new color catalog from Sperry Gyroscope Co., Div., Sperry Corp., Great Neck, N. Y.—AVIATION, Oct., '45.

Pressed Brass Forgings 2

Large scale illustrations of special hot pressed brass and bronze forgings are contained in folder from Titan Metal Mfg. Co., Bellefonte, Pa.—AVIATION, Oct., '45.

PRODUCTION

Salt Bath Furnaces 3

Describing principle of immersed electrode type salt bath furnace, *Salt Baths for Process Annealing, Cyclic Annealing, and Descaling*, technical article from Ajax Electric Co., Philadelphia, gives application of equipment, processing methods, floor area, and cost figures.—AVIATION, Oct., '45.

Industrial Oxygen 4

Uses of oxygen in industry and details of its production are given in booklet from Air Reduction Sales Co., New York City, titled *Oxygen—Indispensable Servant of Industry*.—AVIATION, Oct., '45.

Grinding and Finishing 5

Illustrating industrial applications of "Wetordry" method of grinding and finishing, booklet titled *Faster, Better Finishing of Metal, Plastic and Glass* has been released by Minnesota Mining & Mfg. Co., St. Paul.—AVIATION, Oct., '45.

Soldering Flux 6

Polan Industries, Huntington, W. Va., announces availability to industry of company's "Zenith" super flux.—AVIATION, Oct., '45.

Carbon Restoration Process 7

Illustrating difference between normal heat treatment and skin recovery, or carbon restoration process, Bulletin No. SC-125, from Surface Combustion Co., Toledo, describes process and covers applications.—AVIATION, Oct., '45.

Self-Sealing Couplings 8

Bulletin No. 107 from Aeroquip Corp., Jackson, Mich., contains descriptions and specifications of company's self-sealing couplings, developed to enable disconnection of liquid carrying lines without need of draining system and priming.—AVIATION, Oct., '45.

Copper-Base Alloy Progress 9

Bulletin No. 71, from Ampco Metal, Milwaukee, is colorful institutional publication describing plant and products, and illustrating progress in production of copper-base alloys.—AVIATION, Oct., '45.

Rust Inhibiting Treatment 10

Circular from Protective Coatings, Detroit, describes company products, particularly "Micronoil Riso," new rust inhibitor for metal parts.—AVIATION, Oct., '45.

Degreaser 11

Non-phenolic type degreasing compound is topic of circular from E. A. Gerlach Co., Philadelphia.—AVIATION, Oct., '45.

Bronze Bushings and Bars 12

Machined bronze bars and finished bushings, including grooved styles, are detailed in Catalog No. 45 from Shook Bronze Corp., Lima, Ohio. Comprehensive bushing listings are feature.—AVIATION, Oct., '45.

Thread Cutting Screws 13

Shakeproof, Inc., Chicago, has issued folder descriptive of Type 1 thread-cutting screws.—AVIATION, Oct., '45.

Fuel Booster Pump 14

Reported to have more positive vapor separating characteristics to handle larger fuel flow, new electric-motor driven centrifugal pump with one moving part is described in Bulletin No. 9 from Pesco Products Co., Div., Borg Warner Co., Cleveland.—AVIATION, Oct. '45.

Heating Operations 15

Ajax Electrothermic Corp., Trenton, N. J., has issued Bulletin No. 25 containing information on heating, forging, hardening, and other operations on metals and industrial machines.—AVIATION, Oct., '45.

Panel Dial Plates 16

Gummed plastic plates stated to make a permanent bond are described in circular from Pennsylvania Plastic Corp., Pittsburgh.—AVIATION, Oct., '45.

Gasket Sealer 17

Non-inflammable gasket sealer "Sumtex" MM-50, for aircraft, manufactured by Summit Paint & Varnish Co., Hartford, Conn., is described in folder.—AVIATION, Oct., '45.

Ball Anodes for Plating 18

Circular from Udylite Corp., Detroit, describes uses of ball anodes in solving plating problems.—AVIATION, Oct., '45.

Metal Sawing 19

Recommendations on use of hand and power hack saws, with instructions on operation and adjustment of metal cutting band saws, are contained in *Handbook of Metal Sawing*, from W. O. Barnes Co., Detroit.—AVIATION, Oct., '45.

Tool Steel Drill Rod 20

Information on selection of tool steel drill rod, also heat treatment, is contained in booklet from Carpenter Steel Co., Reading, Penn.—AVIATION, Oct., '45.

MACHINERY & ACCESSORIES

Balancing Ways 21

Reported to simplify static balancing straightening, and truing operations, and to obtain sensitivity to .007 oz.-in. in small 10-in. size (.009 in. 20- and 42-in. sizes) balancing ways, made by Ideal Commutator Dresser Co., Sycamore, Ill., are described in circular.—AVIATION, Oct., '45.

AVIATION READER'S SERVICE

OCTOBER 1945

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31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48
49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66
67 68 69 70 71 72 73 74 75 76 77 78 79

NEW PRODUCTS: 80 81 82 83 84 85 86 87 88 89 90 91 92
93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110
111 112

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Dynamometer Manual 22

Description and applications of traction type dynamometer made by W. C. Dillon & Co., Chicago, are contained in new company manual.—AVIATION, Oct., '45.

Metal Cutting Tools 23

Catalog from Haynes Stellite Co., Kokomo, Ind., contains descriptions, engineering drawings, and specifications of company's metal cutting tools.—AVIATION, Oct., '45.

Conveyor 24

New lightweight portable gravity conveyor, made by Lamson Corp., Syracuse, N. Y., is described in folder.—AVIATION, Oct., '45.

Centrifugal Casting 25

Featuring heat-free "miracle hub", centrifugal casting machine made by Centrifugal Machine & Engineering Co., Kalamazoo, Mich., is described and specifications given in circular.—AVIATION, Oct., '45.

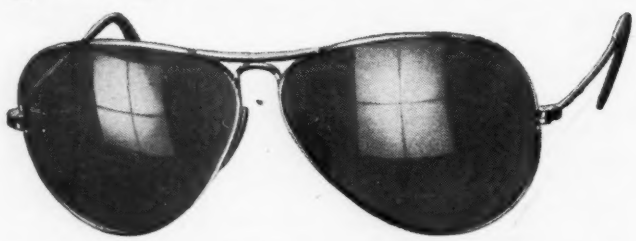
Cutting Tools 26

Circular from Continental Tool Works, Detroit, lists line of cutting tools, including broaches, made by company.—AVIATION, Oct., '45.

Multiple Screw Driver 27

Containing nine bits or wrenches to fit each of the many screw heads in use, "Unbrako" key kit, a multiple screwdriver developed by Standard Pressed Steel Co., Jenkintown, Pa., is described in color folder.—AVIATION, Oct., '45.

CHOICE OF CHAMPIONS



FOR EYE COMFORT OUT-OF-DOORS

Ray-Ban SUN GLASSES

Safe, scientific glare protection—that's what the Ray-Ban formula means to those who work and play out-of-doors. The cool, sage-green Ray-Ban lenses shut out the sun's hot infra-red rays and the burning ultra-violet rays. All the light useful for seeing comes through—colors are unchanged.

Ask the men who wore Ray-Bans on the fighting fronts . . . on land, at sea, and in the air . . . why they prefer these superb sun glasses. Genuine Ray-Bans will soon be available . . . don't accept substitutes. Bausch & Lomb Optical Co., Rochester 2, N. Y.

BAUSCH & LOMB

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BAUSCH & LOMB IS DESIGNER AND PRODUCER OF BINOCULARS, SPOTTING SCOPES, RAY-BAN SUN GLASSES AND A COMPLETE LINE OF OPTICAL INSTRUMENTS

Boring-Drilling Machine 28

Described as having wide field of application through use of hydraulic table feed system which has range of operating characteristics necessary for drilling materials of high or low density, Style CDH hydraulic Feed multiple drilling and boring machine, made by B. M. Root Co., York, Pa., is described in Bulletin No. 131.—AVIATION, Oct., '45.

Rotameter 29

Fischer & Porter Co., Hatboro, Pa., has issued three catalog sections as follows: No. 98-Y, *Theory of the Rotameter;* No. 10-C, *A New Era in Flow Rate Measurement;* and No. 43-E, dealing with armored rotameters.—AVIATION, Oct., '45.

Resistant Materials 30

Corrosion-resistant materials and equipment now available from U. S. Stoneware Co., Akron, Ohio are detailed in special booklet.—AVIATION, Oct., '45.

Aviation Industry Pumps 31

Use of water, oil, and gasoline pumps in aviation industry are covered in booklet, *Deming Pumps Everywhere,* issued by Deming Co., Salem, Ohio.—AVIATION, Oct., '45.

Fuel Injection Nozzle 32

Written to explain fundamentals, booklet from Fuel Injection Div., Ex-Cell-O Corp., Detroit, describes operation of fuel injection nozzle for Diesel and gasoline engines.—AVIATION, Oct., '45.

Machinists' Tools 33

Products Engineering Co., Beverly Hills, Calif., announces literature on toggle clamps, drill bushings, gages, aircraft tools, rivet sets, and other hand units.—AVIATION, Oct., '45.

Illuminated Magnification 34

"Magni-Ray", illuminated magnifier for use anywhere that close inspection of magnified object is desired, is described in circular from George Scherr Co., New York City.—AVIATION, Oct., '45.

Shankless Twist Drills 35

Development of roll-forged shankless twist drills, also their economies and efficiencies, are treated in booklet from Republic Drill & Tool Co., Chicago.—AVIATION, Oct., '45.

Pull-Down Broaching Machines 36

Specifications and description of line of pull-down broaching machines, suitable for internal work and for large or heavy parts, are contained in Bulletin VMS-45 from Colonial Broach Co., Detroit.—AVIATION, Oct., '45.

Gear Chucks 37

Circular from Garrison Machine Works, Dayton, Ohio, illustrates various types of company's pitch line control gear chucks.—AVIATION, Oct., '45.

Tools and Gages 38

Condensed catalog from Pratt & Whitney Div., Niles-Bement-Pond Co., West Hartford, Conn., describes line of units, including machine tools, Keller machines, Kellerflex, small tools, and agency sales items.—AVIATION, Oct., '45.

Flexible-Shaft Machines 39

Catalog No. 44, from Wyzenbeck & Staff, Chicago, describes flexible-shaft machines and equipment, "Hy-Speed" saw, hole and washer cutters, angle drilling attachments, and other tools and equipment.—AVIATION, Oct., '45.

Die Maintenance 40

"Strippits", spring die stripping units made by Wales-Strippit Corp., North Tonawanda, N. Y., are described in Catalog S.—AVIATION, Oct., '45.

Hot Marking Plastics 41

Information is available on devices for hot marking plastics by several methods. Maker is Acromark Co., Elizabeth, N. J.—AVIATION, Oct., '45.

Bending Machine 42

O'Neil-Irwin Mfg. Co., Minneapolis, offers information on improvements to original "Di-Acro" bender, made in three sizes.—AVIATION, Oct., '45.

Grinding and Finishing 43

Grinding and Finishing With Idler Backstands is title of folder from Behr-Manning, Troy, N. Y. Presented is complete engineering and production data on latest methods.—AVIATION, Oct., '45.

Hardness Tester 44

Information is offered by Clark Instrument Co., Dearborn, Mich., on new model hardness tester designed to handle large or cumbersome parts.—AVIATION, Oct., '45.

Screwdriver Set 45

New type tool driver, featuring detachable blades to fit any size screw, is described in circular from Speedway Engineering Co., Los Angeles.—AVIATION, Oct., '45.

Industrial Truck 46

Market Forge Co., Everett, Mass., offers information on new type industrial truck stated to be easily convertible for many types of jobs through use of standard accessories.—AVIATION, Oct., '45.

Inspection Mirrors 47

Information is available on inspection, or mechanics', mirrors, made in three sizes by Ullman Products Co., Brooklyn, N. Y.—AVIATION, Oct., '45.

Work Bench 48

Equipto Div. of Aurora Equipment Co., Aurora, Ill., has issued folder descriptive of combination work bench and table made of steel.—AVIATION, Oct., '45.

Brake Drum Lathe 49

Descriptive matter is offered by Barret Equipment Co., St. Louis, on new portable brake drum lathe for field service work or for operations where it is advantageous to bring machine to job.—AVIATION, Oct., '45.

Portable Beam Scale 50

Circular 608-P from Howe Scale Co., Rutland, Vt., describes No. 54 modernized portable beam scale which has 1,000-lb. cap.—AVIATION, Oct., '45.

Die Casting Machines.....51

Booklet from H. L. Harvill Mfg. Co., Vernon, Calif., describes three new types of die casting machines. Included is information on a fourth type, Model HD-1AM1, for casting tin, lead, and zinc alloys.—AVIATION, Oct., '45.

Electric Blowers 52

Industrial and commercial vacuum cleaners and other electric blowers made by Breuer Mfg. Co., Chicago, are described in circular.—AVIATION, Oct., '45.

Spray Booths 54

Wet dust collectors and spray booths made by Metallizing Engineering Co., Long Island City, N. Y., are described in Bulletin 43A.—AVIATION, Oct., '45.

Thread Plug Gages 55

Descriptive literature is available on thread plug gages made of "Tantung", non-ferrous hard alloy. Manufacturer is Master Gauge Co., Detroit.—AVIATION, Oct., '45.

Toggle Clamp 56

Bulletin from Mechanics Engineering Co., Jackson, Mich., describes new "Mech-Master" toggle clamp, stated to feature wide clamping range and to be instantly adjustable.—AVIATION, Oct., '45.

Electronic Gaging Instrument 57

Capable of automatically gaging wide variety of small parts, Model 700 electric gaging machine called "Autotron" is described in circular from Autotron Co., Danville, Ill.—AVIATION, Oct., '45.

New Metallizing Gun 58

Reported to effect new economies in maintenance, production, and corrosion-prevention spraying operations, a new metallizing gun produced by Metallizing Co., of America, Chicago, is described in Bulletin No. F-1A.—AVIATION, Oct., '45.

ELECTRICAL

Multi-Cellular Speaker 59

Reported to deliver 60-deg. horizontal and 40-deg. vertical distribution, with low distortion, two-way multi-cellular "Duplex" loudspeaker made by Altec Lansing Corp., Hollywood, Calif., is described in booklet.—AVIATION, Oct., '45.

Electronic Tube Manual 60

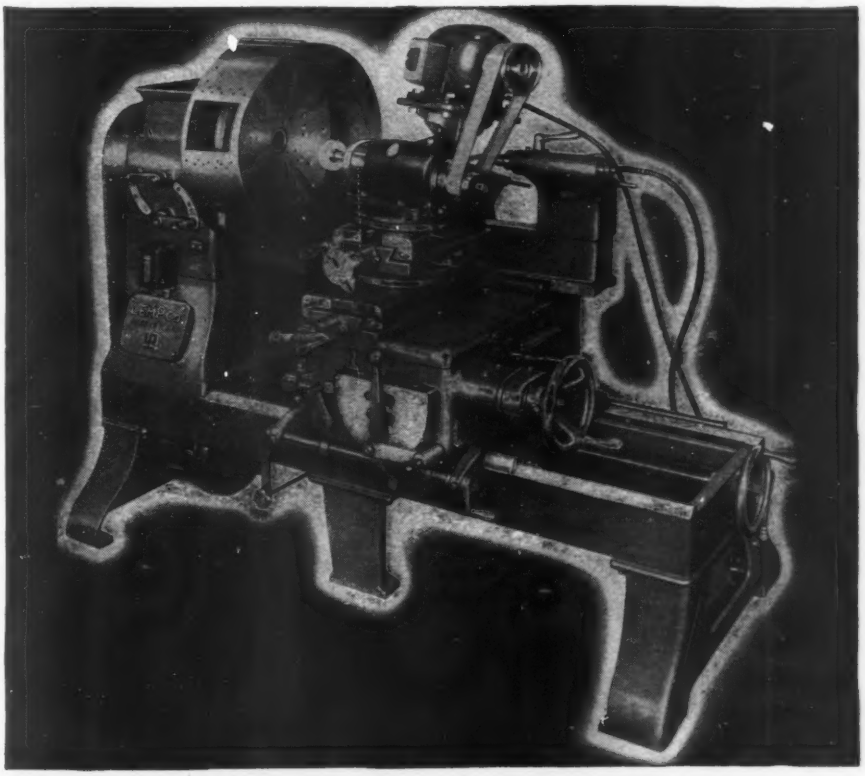
General Electric Co., Schenectady, N. Y., has issued new 412-page electronic tube manual to be sold to trade. A guide to proper selection, it is in loose leaf form, and new data will be supplied at nominal annual fee.—AVIATION, Oct., '45.

Electrical Contact Catalog 61

Stackpole Carbon Co., St. Marys, Pa., announces new electrical contact catalog and data book which contains description of company's products, also pertinent technical information.—AVIATION, Oct., '45.

Electrical Equipment Brochures 62

Listed in separate brochures by Walker-Jimieson, Chicago, is equipment for voltage supply, lighting, shop tools, sound, maintenance, and test and inspection.—AVIATION, Oct., '45.



THE **GRINDER** WITH A **53" SWING!**

The new Model HGX Lempco Heavy-Duty Universal Grinder, is particularly adapted for postwar work. For it is one of the most versatile machine tools made. It does fast, precision turning and grinding on internal, external, face, and taper jobs. Its unusually large 53" swing enables it to do many jobs that no other grinder in its price range can do. Exclusive Lampco hollow spindle draw-bar mounting. Quick-change spindle speed and carriage feed are automatic in both directions. Ceiling-priced. Good delivery.

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Elements of Electronics 63

Dr. Walter Richter, of Allis-Chalmers Mfg. Co., Milwaukee, has prepared educational booklet *Introduction to Electronics*, designed to give an idea of part electronics will play in industry, plus an understanding of its principles.—AVIATION, Oct., '45.

Electronics Fundamentals 64

Basic facts about electronics, described in simple language and illustrated with cartoons, are given in booklet *The Amazing Electron*, issued by Electronic Corp. of America, New York City.—AVIATION, Oct., '45.

Fluorescent Lighting Capacitors 65

Tobe Deutschmann Corp., Canton, Mass., offers detailed data on new power factor correction capacitors for fluorescent lighting circuits employed in industry.—AVIATION, Oct., '45.

Crystal and Holder Assembly 66

Bulletin No. SE-111, from Bendix Radio, Baltimore, described general characteristics and specifications of MX-9 Series crystal and holder assembly. Unit is designed for frequency control in communication and experimental service.—AVIATION, Oct., '45.

Two-Beam Cathode Ray 67

Information is available on double-beam cathode ray tube Type 5SP, manufactured by Allen B. Du Mont Laboratories, Passaic, N. J. Tube provides two complete "guns" in single glass envelope.—AVIATION, Oct., '45.

PLASTICS & SYNTHETICS

Plastic Component 68

Uses of chemical melamine in plastics, textile, paper, chemical, paint, and allied industries, are given in booklet from American Cyanamid Co., New York City.—AVIATION, Oct., '45.

Resorcinol Adhesive 69

Resinous Products & Chemical Co., Philadelphia, offers information on new room temperature setting resorcinol adhesive called "Amberlite" PR-115. Developed for gluing wood to wood, resin is stated to show good adhesion to laminates, rubber, and transparent plastics.—AVIATION, Oct., '45.

PLANT MATERIALS

Flooring 70

"Stonoleum", flooring material described as bonding directly to old floor without use of bonding agent, is detailed in bulletin from Continental Asbestos & Refining Corp., New York City.—AVIATION, Oct., '45.

Water Filter 71

Bulletin No. 675 from R. P. Adams Co., Buffalo, contains description of Model TF-1 twin water filter, self contained unit for use wherever water must be "polished".—AVIATION, Oct., '45.

Adjustable Bench Light 72

Catalog No. 111 from Swivelier Co., New York City, concerns new line of "Work-Lites", electrical lighting fixtures for machine, bench, or desk. Units are adjustable and may be had in various sizes and types of shades.—AVIATION, Oct., '45.

Floor Resurfacer 73

Described in circular from Tufcrete Co., Des Moines, Iowa, is "Tufcrete" floor resurfacer which may be used over wood, concrete, brick, or other type flooring, or it may be used as complete new surface.—AVIATION, Oct., '45.

Fluorescent Lamp Lock 74

Laduby Co., New Haven, Conn., offers circular on "Flur-O-Locks", device designed to prevent loosening and falling of fluorescent lamps.—AVIATION, Oct., '45.

White Floors 75

Light From Floors is title of booklet from Atlas Cement Co., subsidiary of U. S. Steel Corp., New York City. Re-edited and re-arranged for reconversion period, booklet emphasizes advantages of white cement floors.—AVIATION, Oct., '45.

Recessed Fluorescent Fixtures 76

Bulletin No. 203, from R. & W. Wiley, Buffalo, treats of new type fluorescent fixture which may be recessed into ceiling, yet is stated to be easy to service and clean.—AVIATION, Oct., '45.

TRANSPORTATION

Aircraft Hauling 77

Scope of company's special services in handling and hauling of aircraft by tractor-trailer is outlined for manufacturers and commercial and private operators in folder from U. S. Aeroplane Carriers, Dover, Del.—AVIATION, Oct., '45.

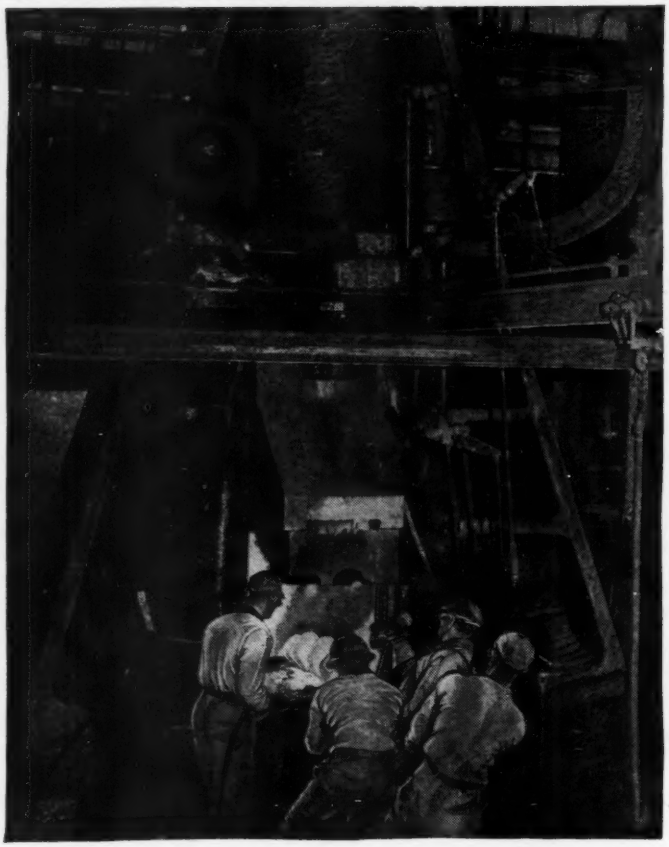
MANAGEMENT AND EMPLOYEES

Incentive Wage Plans 78

Survey of incentive wage plans, conducted by Douglas T. Sterling Co., Stamford, Conn., now appears in booklet covering subject.—AVIATION, Oct, '45.

Employee Relations 79

Elliott Service Co., New York City, offers seven guidance manuals for use of foremen, supervisors, and department heads in meeting employee relations problems. Manuals are described in new illustrated catalog.—AVIATION, Oct., '45.



IN the realm of forging design and the development of proper grain flow, Wyman-Gordon has long pioneered and has originated many forging designs which, at the time of their development, were considered impossible to produce by forging. Wyman-Gordon is foremost in scientific development—the greatest name in forging.

WYMAN-GORDON

Forgings of Aluminum, Magnesium, Steel

WORCESTER, MASSACHUSETTS, U. S. A.

HARVEY, ILLINOIS - DETROIT, MICHIGAN

NEW PRODUCTS

Machinery & Accessories

Straightening Press 80

Power hydraulic straightening press with 6 in. or greater ram stroke and cap.

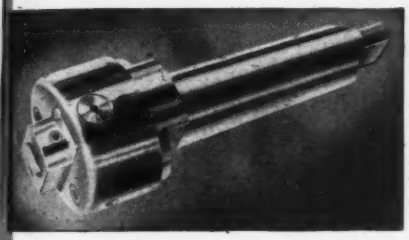
of 50 tons, is announced by **Anderson Bros. Mfg. Co.**, Rockford, Ill. Traveling ram rolls on four ball bearing equipped wheels, and table is equipped with V-slide in which are mounted spring loaded centers and checking rolls. Machine indicates amount of runout, where to stop shaft and do straightening, and, during operation, shows how much shaft is being bent. Then when pressure is released it shows result of first "try" and offers guide for next operation.—**AVIATION, Oct., '45.**

Over-Running Clutch 81

Gear Grinding Machine Co., Detroit, announces "Formsprag," new full-complement over-running clutch consisting of cylindrical inner and outer races, annular space between them being filled with accurately formed sprags. Contact with both surfaces is maintained by an energizing annular spring at each end of sprags. When torque is applied, all sprags are rotated, gripping inner and outer races and forming what is practically a single piece of metal. With torque removed, all sprags are stated to release instantaneously.—**AVIATION, Oct., '45.**

Boring Chuck 82

Designed for use on large mills and boring mills, and having boring capacity as large as 26 in. dia., boring chuck made by **De Soto Tool Co.**, Detroit, is described as enabling operator to center drill, bore a hole or holes, and then drill again without removing boring chuck. When drilling is required, boring bar is removed and chuck brought to dead-center by moving adjusting screw to end of travel and setting to

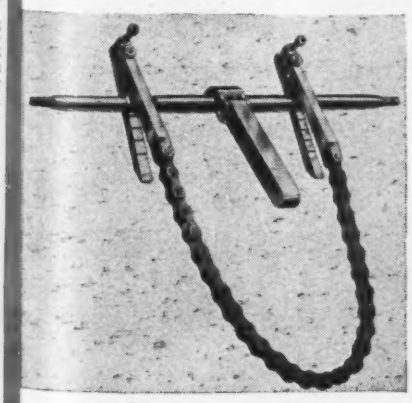


zero. Boring chuck is then ready to receive drill chuck. After drilling, drill chuck is removed and boring bar inserted. Chuck may be used as adapter for most special tools, such as end mills, cutters, key-way cutters, saws; and fly tools. Accessories are 9-in. boring bar, boring adapter, right angle, 20-deg. flytool adapter, end mill reducer ½ to ⅜ in., boring bar reducer ¾ to ⅝ in., short boring bar 5 in., and end mill reducer.—**AVIATION, Oct., '45.**

Shop Equipment & Materials

Turnbuckle Adjustment Set.....83

Consisting of turnbuckle wrench and two V-shaped retainers connected by 12 in. length of link chain, new turnbuckle adjustment set developed by **Aero Tool Co.**, Burbank, Calif., is reported to be time saver. When retainers are dropped over swaged-cable fitting, converging steps in retainers find their own adjust-



A DRAWING BOARD IN A *Foundry?*

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WE don't put our drawing boards right out on the foundry floor. But Acme does offer a design service which has proved helpful to many users of Acme Permanent Mold Aluminum Castings. Acme engineers, through their long experience in making tools and patterns, and in working with aluminum and its alloys, can frequently suggest constructive changes in design. Such a change may, for instance, lead to the use of less metal with no sacrifice in casting strength, and a saving to the customer.

Whether or not you call upon the advisory service of Acme engineers, you will gain the benefit of modern production facilities and quality control in the production of your castings. Acme facilities include pattern and tool shop, as well as one of today's most modernly equipped foundries. Close temperature control and rigid inspection methods guard the quality of every Acme casting.

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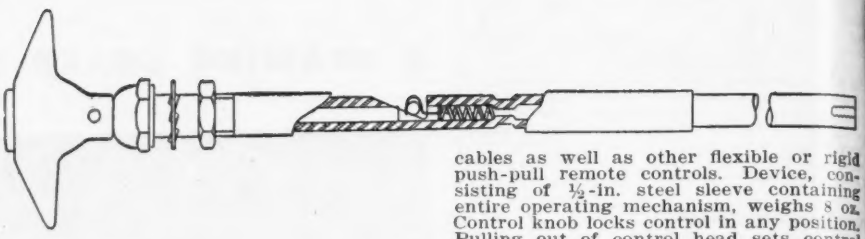
ment on any fitting from $\frac{3}{16}$ to $\frac{11}{16}$ in. dia., weight of chain holding them in position, with set-screw provided in case of need. Chain acts as rigid bar against simultaneous clockwise and counter clockwise torque of cable fitting set up when turnbuckle is turned, while its vertical flexibility permits adequate clearance in tight spots.—**AVIATION, Oct., '45.**

Portable Industrial Controls.....84

Assemblies developed by **Brown Instrument Div., Minneapolis-Honeywell Regulator Co.,** Philadelphia, are described as improving portability of industrial instruments. Offered are: (1) Cast carrying handle, plus parts, for smaller instruments, such as meters and gages: and (2) two locker-type carrying handles, with feet and necessary assembly parts for heavier potentiometer types, including electronic.—**AVIATION, Oct., '45.**

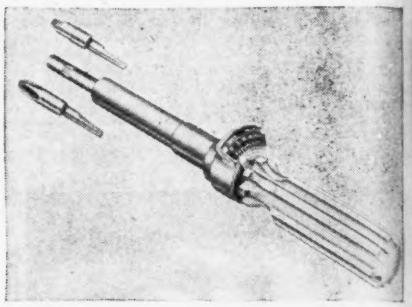


Tension Lock Control.....85

Described as offering positive lock for difficult control jobs, with ability to hold any load pressure which can be applied by hand, new push-pull tension lock control produced by **Arens Controls,** Chicago, can be used in combination with rods and cables as well as other flexible or rigid push-pull remote controls. Device, consisting of ½-in. steel sleeve containing entire operating mechanism, weighs 8 oz. Control knob locks control in any position. Pulling out of control head sets control to any position, as wedge key inside control wedges itself against wall of outer sleeve preventing inner sliding member from moving. Pushing button on head depresses spring, which in turn actuates wedge pin, permitting sliding member to be moved in.—**AVIATION, Oct., '45.**

Torque Screwdriver 86

With basic principle and construction identical with those of maker's torque wrenches, new torque screwdriver has been developed by **Apco Mossberg Co.,** Attleboro, Mass. In.-lb. are indicated directly on dial without use of springs, and range is from 0 to 25 in.-lb. Two bits are furnished, one for Phillips screws and one for slotted screws, together with adapter for ¼-in. square sockets.—**AVIATION, Oct., '45.**

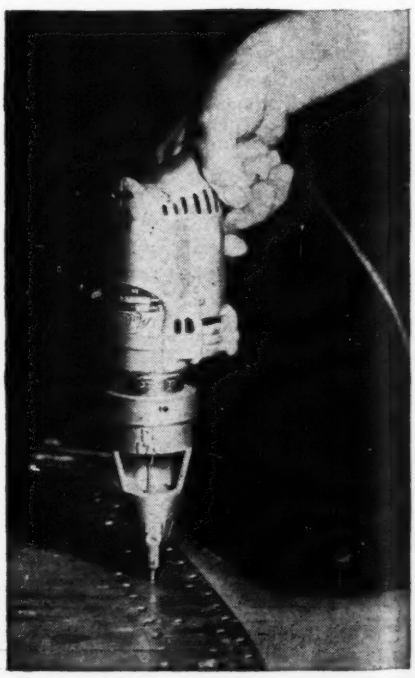


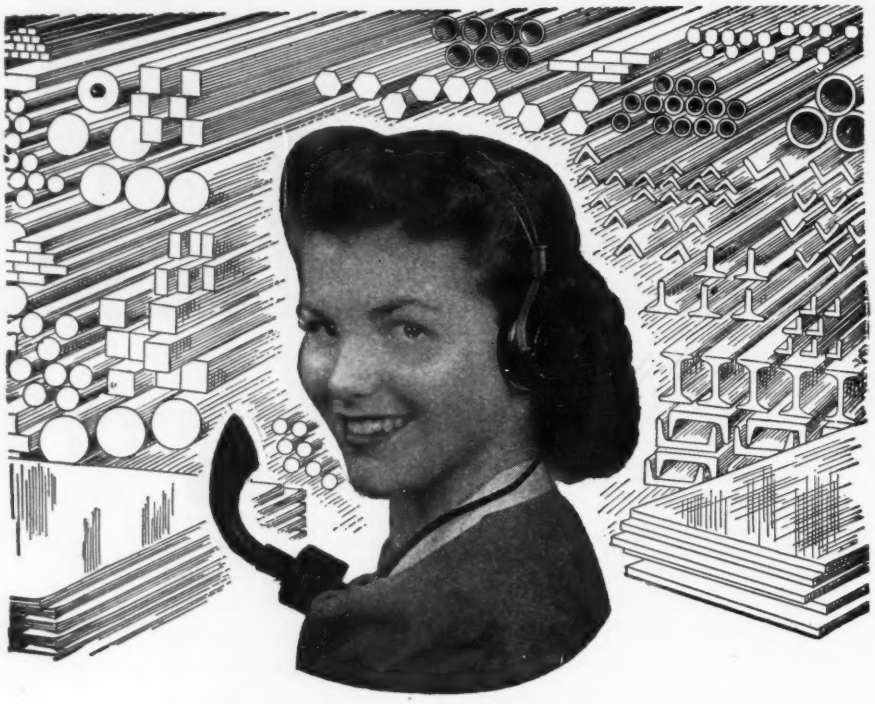
Controlled Pickling Inhibitor.....87

Reported to protect metal and save acid by working on scale only, new controlled pickling inhibitor developed by **Kelite Products,** Los Angeles, is called "Kelite Control." It is stated to reduce possibility of hydrogen imbrittlement.—**AVIATION, Oct., '45.**

Drill Guide Pressure Foot.....88

Drill guide pressure foot, made by **Products Engineering Co.,** Beverly Hills, Calif., is used with hand motors in jig template drilling. It is now offered in new design and aluminum construction.—**AVIATION, Oct., '45.**





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This General Motors Propeller Is Engineered for Easy Maintenance

THIS WAR has proved that easy maintenance is a "must" in any aircraft part. That's one of many reasons why the Aeroprop is in such demand today, and why it will serve you so well tomorrow.

The Aeroprop is remarkably clean and simple in design. It can be inspected and serviced in record time. A single blade, or the complete propeller, can be removed and replaced in a matter of minutes. In war, that means fewer hours wasted on the ground. In peace, Aeroprop simplicity will help to shorten maintenance time and contribute to the economy, efficiency, and reliability of commercial flying.

This General Motors Propeller is one of many war-proved developments that will serve the flying public when the achievements of America's aircraft and accessory industries are converted to planes of peace.

Aeroprop Advantages—*Lightness* for payload . . . *Strength* for safety . . . *Simplicity* for easy service . . . *Faster Automatic Pitch Change* for flight efficiency . . . *Full Feathering* for engine protection . . . *Engineered* for reliability.

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AEROPRODUCTS DIVISION • GENERAL MOTORS CORPORATION • DAYTON, OHIO

Keep them flying—Buy Another War Bond!

Again Apex helps the users of Phillips Screws!

APEX announces a series of bit holders that absolutely revolutionizes the use of Power Bits and Hand Drivers for Phillips Recessed Head Screws. Here's what they do:

One Save you money after original installation of holders is made because they eliminate necessity of carrying so many different sizes of screw driver bits. The insert tips are the only items necessary for you to carry in stock. One range of inserts fits various sizes of holders.

Two Save vitally needed critical steel and release it for other war time users.

Three Increase bit life due to the float between insert and holder, allowing for easier direct alignment with recess in screw.

Four Decrease handling cost of screw driver bits because it is no longer necessary to return screw drivers for reconditioning as cost of inserts is approximately that of the reconditioning charge.

Send for Bulletin No. 102 giving complete details.

APEX

THE APEX MACHINE & TOOL COMPANY • DAYTON, OHIO

Manufacturers of Power Bits for Phillips, Slotted Head and Clutch Head Screws; and Hand Tools for Phillips and Clutch Head Screws.

Plastic Adhesive 89

Suitable for lightweight, high strength sandwich construction, and other mass production bonding of materials, "Cordo-Bond" adhesive No. 250, made by **Cordo Chemical Corp.**, Norwalk, Conn., is reported to bond quickly by baking at glue-line temperature of 250 deg. F. under pressure of 50 psi.—**AVIATION, Oct., '45.**

Sintered Carbide Dies 90

Making use of inserts of "Diecarb," sintered carbide combinations with Rockwell hardness of 65 to 73, blanking and forming dies made by **Firth-Sterling Steel Co.**, McKeesport, Pa., are reported to multiply many times the number of pieces per grind. Material is available in four grades. Company is prepared to provide die-makers with engineering assistance covering design of complete die, as well as methods of applying inserts in various ways and recommendations on grinding.—**AVIATION, Oct., '45.**

ANNOUNCEMENTS—

of new machinery, shop equipment and materials, electrical appliances, and aircraft parts and field units are invited.

In writing, emphasis upon specific aviation applications of newly marketed items is desirable. Also, whenever possible, glossy-print photos should be enclosed. Please do not send electros. Address—

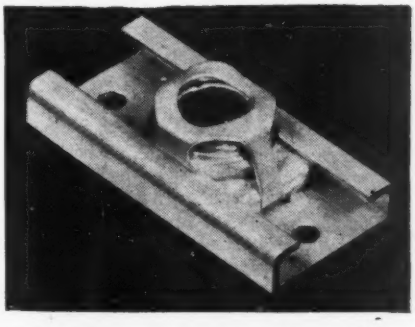
New Products Editor, AVIATION
330 W. 42d St., New York City 18

Mobile Crane 91

Crane built by **Hyster Co.**, Portland, Ore., is of 10,000 lb. cap. and is stated to be equally facile inside buildings and outside on lots with rough and uneven surfaces. It is known as the "Karry Krane".—**AVIATION, Oct., '45.**

Floating Anchor Nut 92

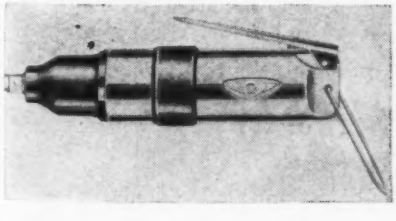
Described as employing replaceable standard nuts, new floating anchor nut made by **Kaynar Mfg. Co.**, Los Angeles is available in sizes from No. 6-32 to ⅜ in.-24. Unit consists of base, retainer,



standard nut, and steel spring clip, assembled. Clip holds nut securely but can be pried up with screw driver to permit replacement of damaged nut. Unit has base of high strength aluminum. It can be used with high temperature nuts, up to 650 deg. F.—**AVIATION, Oct., '45.**

Impact Wrench 93

Reported to be suited to assembly-line jobs of nut-setting and screw-driving, new ¼-in. cap. pneumatic impact wrench with straight type grip and lever control



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Since 1932, we have manufactured tens of thousands of welded tubular assemblies and forgings for aircraft . . . building precision-made parts for most larger aircraft producers.

Now, we also are manufacturing many articles of Ramp and Hangar Equipment for the Airlines . . . "ground" equipment so necessary in keeping vital wartime air traffic "on the move."

Requirements of Ramp and Hangar Equipment manufacturing for the Airlines are varied. Only a few items are of standard design and specification permitting the economies and improvements possible in production line procedure. Whether the need is of individual or standard specification, we are fully staffed and equipped to produce as ordered.

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BROKEN OVERHEAD GASOLINE LINE FIRE KNOCKED OUT IN SIXTY-FIVE SECONDS

NEW DUAL-STREAM NOZZLE

Further increases fire-fighting effectiveness of

DUGAS EXTINGUISHERS

Pictured above is a rigorous test conducted at the DUGAS Division Test Grounds, under observation of Underwriters' Laboratories and Factory Mutual Laboratories. Burning gasoline escaped at the rate of 10 gallons per minute under 50-lb. pressure through three hacksaw cuts in a pipe 13 feet above ground.

Inset shows how quickly the fire was knocked out by DUGAS Dry Chemical after it had been allowed to burn for one full minute. Using the straight stream from the new dual-stream nozzle on a No. 350-A DUGAS Wheeled Extinguisher, the overhead gasoline fire, including blaze on ground, was extinguished in exactly 65 seconds.

NEW DUAL-STREAM NOZZLE...

deals effectively with spill fires and fires difficult to reach because of height or obstructions. Designed for use with DUGAS Wheeled Extinguishers, the new dual-stream nozzle greatly increases fire-fighting range and effectiveness. A turn of the handle gives a straight stream with a range of 45 feet—or a fan stream with a range of 15 feet.

Quick Facts About DUGAS Dry Chemical

1—For extra-hazardous fires involving flammable gases, liquids, greases or electrical equipment.
2—Not an electrical conductor.
3—Non-toxic, non-corrosive, non-abrasive.
4—Not affected by extreme cold or heat.

DUGAS 350-A WHEELED EXTINGUISHER

Write today for complete information regarding DUGAS Wheeled Extinguishers with the New Dual-Stream Nozzle... and DUGAS Hand Extinguishers.

AN ANSUL PRODUCT
duGas
THE MASTER OF FLAME

Approved by Underwriters' Laboratories, and Factory Mutual Laboratories.

ANSUL CHEMICAL COMPANY, MARINETTE, WISCONSIN
DUGAS DIVISION

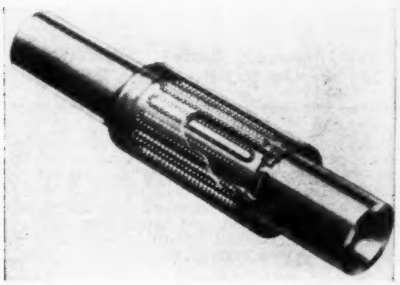
is offered by **Aro Equipment Co.**, Bryan, Ohio. Torque control is obtained primarily through construction of roller clutch impacting mechanism which consists of anvil, hammer, and two cylindrical steel rollers. When in operation, centrifugal force throws rollers out against hammer, where they are caught in shear between hammer and anvil, which transfers full torque to work in form of sudden impact. Model 3012 has ⅜ in. square drive, weighs 1¾ lb., and is 6¾ in. long. —**AVIATION, Oct., '45.**

Aluminum Pre-Cleaner 94

New aluminum pre-cleaner and deoxidizers announced by **Optimus Detergents Co.**, Matawan, N. J., are reported to produce low surface resistance preparatory to spot welding, also to prepare aluminum for Alrok treatment, anodizing, and painting.—**AVIATION, Oct., '45.**

Ball Bearing Bushings 95

Maker of new "Ball Bushing," **Thriftmaster Products Div., Thomson Industries,** Long Island City, N. Y., describes product as giving sliding members same advantage as gained from ball bearings for rotating parts. Bushing contains series of ball circuits, one side of circuit carrying bearing load with other side returning balls in clearance provided in outer race



member. Continuous bearing prevents cocking or binding on shaft. Rolling contact plus sealed-in lubrication provides anti-friction precision alignment. System of ball circuits can be infinitely varied, states maker, for differing load capacities and shapes of bearing members. Bearing may be of considerable length, and of a square, hexagon, or octagonal section.—**AVIATION, Oct., '45.**

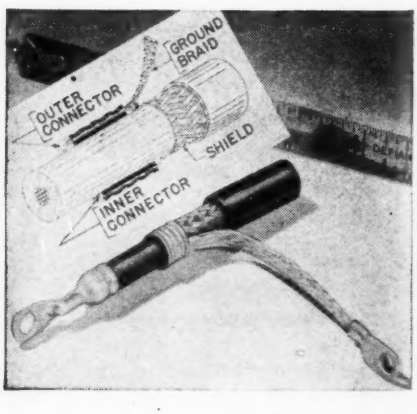
Welding Flux 96

Used for gas welding wrought, cast, or high tensile aluminum and aluminum alloys, "Flo-Well" No. 1, a free-flowing flux, has been produced by **A. K. Mauk**, Pittsburgh, Pa.—**AVIATION, Oct., '45.**

Electrical Appliances

Coaxial Terminals 97

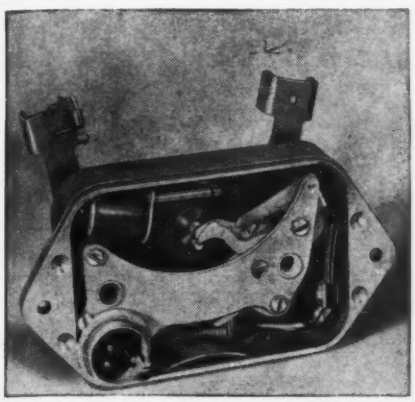
Burndy Engineering Co., New York City, announces new terminals and ground-tap connectors for coaxial and shielded cable which are installed by indenting with "Hytools," without use of solder. Connector for braided conductor or shield may be installed with braid tap to make termi-



nal connection or ground tap, or it may be used to anchor shield to prevent braid from slipping. Connection with inner conductor is made with "Hylug" having an insulation shroud. Outer conductor or shield is grounded or terminated by connection which consists of two ferrules and braided tap. Smaller ferrule, which is slipped between inner insulation and outer conductor, is used to take up pressure when assembly is crimped. Larger ferrule, accommodating braid-jumper tap, is slipped over outer conductor. Entire assembly is then crimped with interlocking dies.—**AVIATION, Oct., '45.**

Rotary Solenoid 98

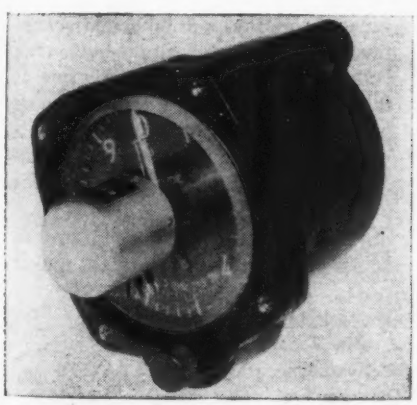
Applicable to many controls in aviation, "Ledex" rotary solenoid developed by **George H. Leland Development Engineering,** Dayton, Ohio, is smaller in dia. than



a pocket watch, and about twice as thick. Maker states it delivers many times power of conventional solenoids. When magnet is energized, rotary motion is imparted to upper member. Torsional power of rotating member is stated to be in excess of 4 in.-lb.—**AVIATION, Oct., '45.**

Potentiometer 99

Used for remotely indicating altitude, and to operate recorders and other flight



test equipment, "Microtorque" potentiometer is announced by **G. M. Giannini & Co.,** Pasadena, Calif.—**AVIATION, Oct., '45.**

Wire-Wound Potentiometers 100

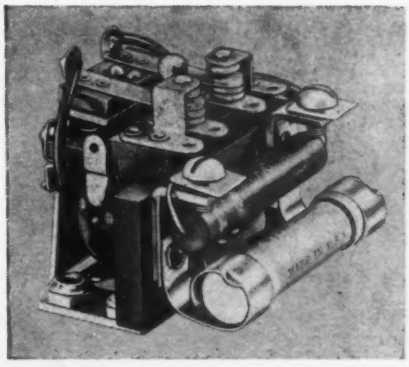
Useful in all major electronic equipment, Series PWW-5 wire-wound potentiometers, manufactured by **Trefz Mfg. Co.,** Flushing, N. Y., are reported to have excellent linearity in single and double units, making them readily adaptable to applications using calibrated dials, or in circuit arrangements where close series or parallel tracking is required. Maker states case can be hermetically sealed when required. Resistance range is 1 ohm to 150,000 ohms. Shafts are made to specifications. —**AVIATION, Oct., '45.**

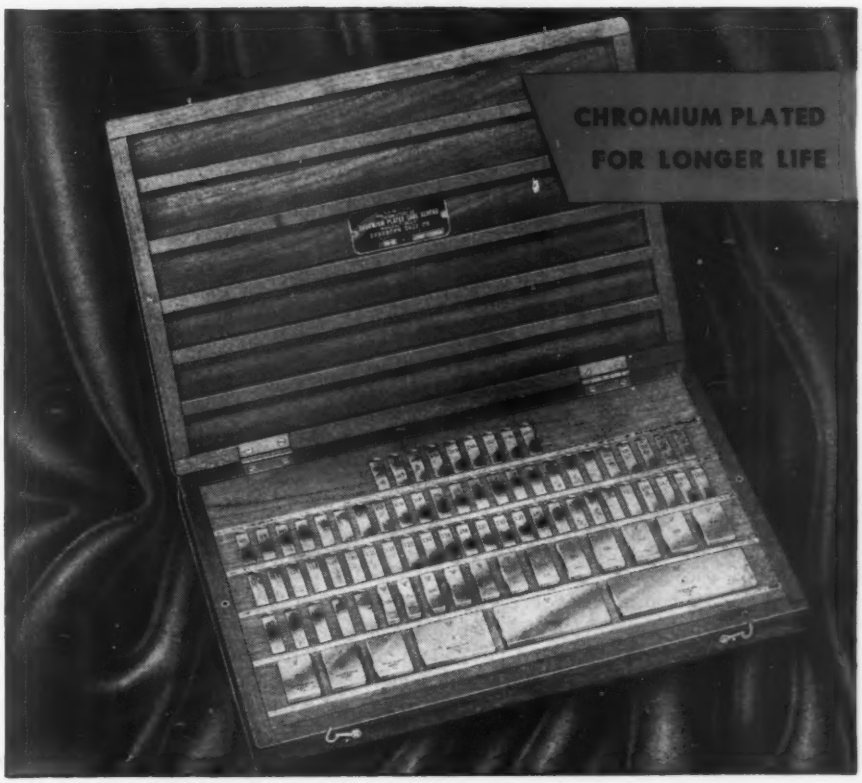
Recording Pressure Transmitter ...101

Recording of pressures on any continuous balance potentiometer are reported possible through use of new pressure transmitter made by **Trimount Instrument Co.,** Chicago. By means of special switching arrangement, more than one pressure can be recorded on same instrument. Installation is stated to involve simple wiring only. Transmitter is usable for gases or liquids for pressure up to 1,000 psi. No batteries or amplification are required.—**AVIATION, Oct., '45.**

Flasher-Interrupter Unit 102

For use in aircraft identification lighting, and other applications, flasher-interrupter (see photo) by **Electronic Testing Laboratories,** Newark, N. J., comprises miniature heavy-duty relay, an electrothermal timing device, and non-inductive resistor, all in single assembly weighing 7 oz. Unit is designed to withstand 10 G's. Design is open, but any required enclosure can be furnished, states maker.—**AVIATION, Oct., '45.**





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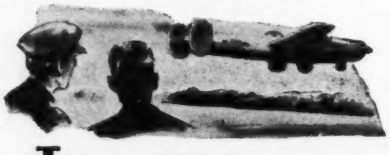
. . . When he comes back—

He comes back with a superb record, a lot of rank, a flock of fruit salad under his silver wings. Great guy! Certainly lucky to have him in the firm . . . Later, though, you begin to wonder. He's polite and pleasant, but a little aloof. Doesn't seem much interested, or catch on fast. Often in a fog, day-dreaming . . . You ask yourself: Has this boy got anything on the ball? Did I pick a lemon? . . . Pause a minute. Put yourself in his place . . .

You spend years learning, and doing the hardest job a man can do. You learn each day you fly can be your last. The Old Man with the Scythe sits nightly by your bedside. You see a man at breakfast one morning; that night you gather up his stuff to ship home, and his empty bunk is awfully hard to take.

You force yourself to do what your mind tells you doesn't make sense; get so tired aloft you don't think you can land; want sleep more than anything, but you can't sleep. A hundred times you say the hell with it, and decide to quit—but don't. You miss the missing men, think the new guys are goofs . . . Finally you fear failure more than getting killed.

Then it's over . . . You want to forget, but can't. Back home, you don't feel as if you belong any more. Normal life isn't normal. No job is as important as what you were doing. You can't get interested, wonder if you'll ever fit—and worry . . .



The best remedy is time. The country spent a lot to teach this man to live dangerously and die; you can afford the few months he needs to settle his nerves and spirit, to readjust to a new life, new capacities and responsibilities. Give him time—to make up for all the living time he has lost. Because this man is one of the best, by any standard. Understanding him now is more important than his understanding the job or your business . . . essential for his future, and for your investment in him!

This advertisement is published in behalf of returned airmen by the maker of the aircraft engine used in training most bomber pilots . . . the Jacobs engine that delivered more flight hours between major overhauls, more performance with less maintenance than any engine on record. Jacobs military record is the best assurance that Jacobs engines—and the men who flew them—will prove a better peacetime investment . . . Jacobs Aircraft Engine Company, *a Division of* Republic Industries, Inc.

JACOBS. Pottstown, Pa.

A Division of Republic Industries, Inc.

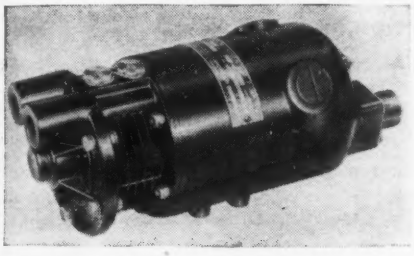
Improved Armature Fabrication....103

New process of winding and forming of coils before they are placed into armature construction is described as giving better balance and ventilation in armature made by **General Armature Corp.**, Lock Haven, Pa. Method is stated to assure that coil contains same length and size of wire, also that stretching of wire is eliminated so that electrical balance is obtained, and that coils are so installed that better circulation is obtained at each end.—**AVIATION, Oct., '45.**

Aircraft Parts & Field Units

Motor-Driven Dry Air Pump.....104

Designed to provide air pressure or suction for several applications, such as fuel tank and ignition harness pressurization, **Eclipse-Pioneer Div., Bendix Aviation Corp.**, Teterboro, N. J., has produced new lightweight motor-driven explosion-proof dry air pump requiring no lubrication. Pump provides theoretical airflow of 4.1 cfm. at 10,000 rpm. It is driven by an



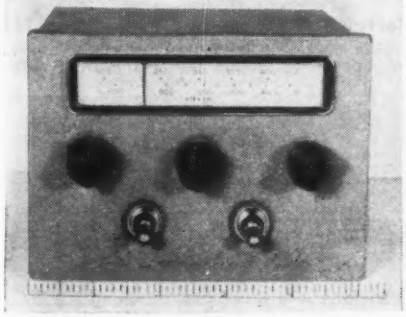
integral 0.2 bhp. 27.5v. d.c. motor. Rated cap. is 0.018 lb. pm. air flow at 11.1 in. hg. abs. inlet pressure, maintaining 31 in. hg. abs. discharge pressure. Max. operating characteristics are: Current draw, 15 amp.; pressure differential, 20 in. hg.; discharge temperature, 300 deg. F.; and minimum flow, 0.01 lb. pm. Pump, which is rotary single-vane type, weighs 4.75 lb., and is 8 21/32 in. long by 3 17/32 in. dia. —**AVIATION, Oct., '45.**

New Engine Lubricant.....105

Carbide & Carbon Chemicals Corp., div. of Union Carbide & Carbon Corp., announces new lubricant for internal combustion engines. Lube contains no petroleum oils. Manufacturer's description: It can be made to any desired viscosity, and is wax-free. Pour-points vary from —30 to —80 deg. F. Flash points range from 300 deg. F. up. Densities approximate that of water. Carbon residue values are less than 0.01%. Change in temperature brings slight change of viscosity, indices being in range of 140 to 160. Maker also states sludge and varnish formation are practically eliminated.—**AVIATION, Oct., '45.**

Two-Way Radio 106

Weighing 10 lb. 10 oz., two-way radio for private aircraft is announced by **Airadio, Inc.**, Stamford, Conn. Set offers plane - to - ground communication, radio range, weather broadcast, and standard broadcast reception. It is also stated adaptable as aircraft interphone. Range signal can be eliminated by means of toggle switch.—**AVIATION, Oct., '45.**



Censored!

BE THANKFUL YOU CAN'T READ SHORTHAND, BROTHER!

So your letters come back all balled up! Sentences transposed, new words substituted, erasures in evidence, margins mangled, and you heap the blame on your steno's head.

Don't do it.

It may not be all her fault. First take a look at the chair she's forced to use. If it cramps her muscles, curves her spine and frays her nerves, *replace it* with a CRAMER POSTURE CHAIR.

Accuracy isn't accidental. Often it's the result of scientific seating comfort such as CRAMER POSTURE CHAIRS provide.

MODEL 2151

Finger-Tip Height Adjustment.

Tubular Steel. Cushioned Comfort.

Available with or without removable covers.

2151-D

Cramer Posture

CHAIR COMPANY

CREATORS OF AIR FLOW COMFORT IN EXECUTIVE, SECRETARIAL, GENERAL OFFICE & FACTORY CHAIRS

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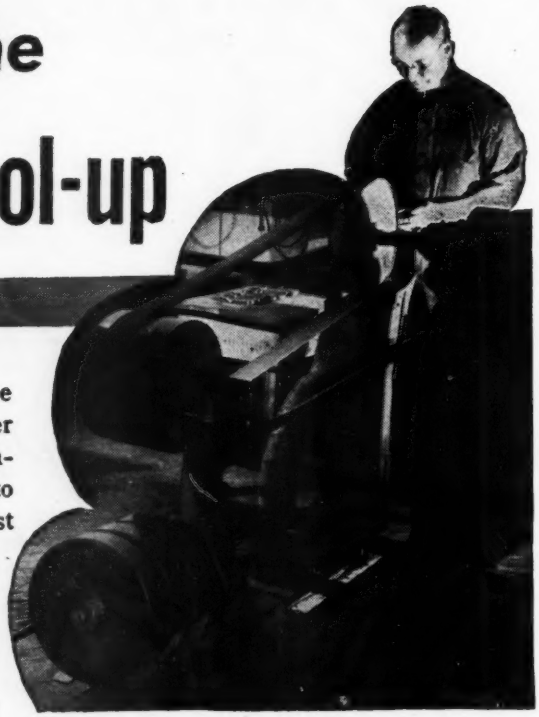
NORTON ABRASIVES

Horse-sense Method for the New Tool-up



SAVE MONEY and time NOW, by changing over your grinding and finishing on set-up wheels to the new and very latest practice—METALITE CLOTH BELTS with IDLER BACK-STANDS.

It's easy to install an Idler Backstand behind your present lathe or polishing jack. Then slip an abrasive cloth belt over the resilient contact wheel to connect the two. Instantly you have new equipment with all these obvious benefits:

- Greater output
- Better finish
- Faster, cooler cut
- Lower cost

The technically controlled sharp surface of METALITE CLOTH BELTS available in 17 grit sizes, uniform from lot to lot, insures fastest possible cutting action.

The belt disperses heat much more effectively than a set-up wheel because of greater area—three times that of the average wheel face.

Both these features, plus time saved in making grit changes, result in better finish at lower cost.

▲

For authentic records of increased performance, as much as 17 to 1; photographs of many and varied installations; names of Backstand manufacturers, and other helpful data, ask for new 8-page folder, "Plus Factors." Use the coupon; you'll be well repaid.

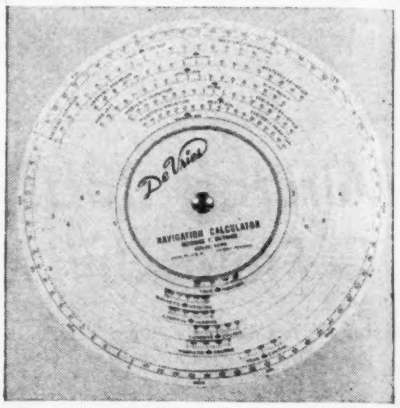
BEHR-MANNING · TROY, N. Y.
(DIVISION OF NORTON COMPANY)
Quality Coated Abrasives Since 1872

BEHR-MANNING, TROY, N. Y. Please send your New, 8-page "Plus Factors" folder on Idler Backstands.

Company.....
Per.....
Address.....
☐ Please have Field Engineer call.

Avigation Calculator 107

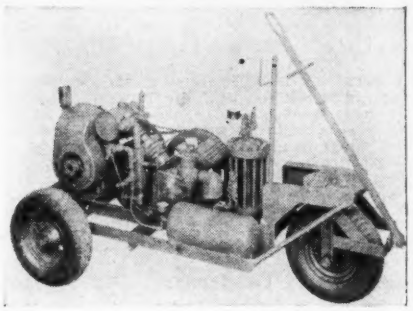
New DeVries avigation calculator, manufactured by **DeVries & Co.**, Grundy Center, Iowa, is stated to solve all problems involving known variation, deviation, and wind drift angle. In addition to plotting



previous to flight, instrument is reported valuable in keeping constant check on calculations while in flight, also in recalculating problems when changes in variables occur during flight. Instrument comprises seven moving disks. Results are read through indexed slots.—**AVIATION, Oct., '45.**

Aircraft Compressor Unit 108

Designed for both high and low pressure service, Model 2000 compressor unit, made by **Pacific Airmotive Corp.**, Glendale, Calif., is mounted on pneumatic tires, is equipped with both tow hitch and manual tongue. Following are com-



ponents: High pressure de-humidifier container for 2,000 lb. working pressure (silica gel); low pressure receiver with safety valve; high pressure and low pressure valves; high pressure and low pressure gages; air adapter valve; and 20 ft. hose. Weight is 650 lb.—**AVIATION, Oct., '45.**

Diaphragm Cloth 109

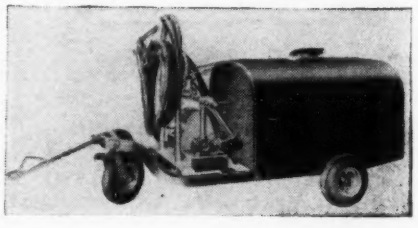
Irvington Varnish & Insulator Co., Irvington, N. J., announces new specially prepared cotton cloth for use in fuel pump diaphragms. Stated to remain flexible, it is reported to offer almost instantaneous recovery over wide range of temperatures. —**AVIATION, Oct., '45.**

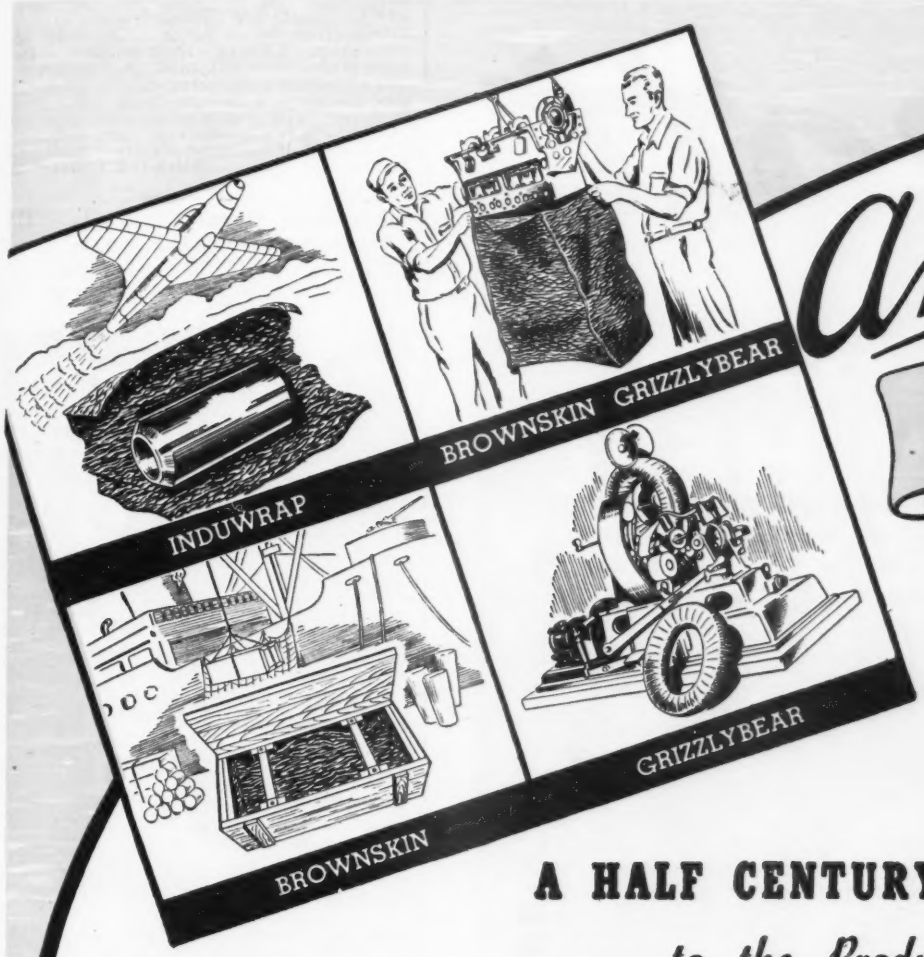
Eddy Current Clutch 110

For driving aircraft accessories such as fans, blowers, compressors, generators, pumps, and windshield wipers, new eddy current clutch, made by **Eaton Mfg. Co.**, Cleveland, provides controllable speed output from variable speed or constant speed input.—**AVIATION, Oct., '45.**

Portable Oil Dispenser 111

Illustrated is new portable engine oil dispenser developed by **Harman Equip-**





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50th Anniversary
1895 - 1945

A HALF CENTURY OF PROTECTION

. . . to the Products of Our Nation and its Industries in Peace and War

Airplane engine and parts manufacturers were up against it for a grease-proof wrapper to prevent corrosion. Angier of Framingham produced it in INDUWRAP, which more than meets any specification ever drawn for a Grade A, Type I wrapper.

Chrysler of Canada engines were in trouble because of damage from the elements while enroute overseas. Angier helped to eliminate this trouble with A-19 BROWNSKIN GRIZZLYBEAR.

The government and many war industries needed for tarpaulins, case-liners and wrappers an extra-tough, non-deteriorating, water-resisting paper to protect countless products of war. Angier met the need with BROWNSKIN.

And Angier GRIZZLYBEAR, in both the asphalt and resinous grades, has been a constant solver of problems confronting shippers of airplane motors and critical wire, much of the latter in spirally-wrapped coils.

Have you an essential problem in product protection? Put it up to Angier engineers.

ASK FOR LITERATURE AND SAMPLES

Please mention by name this magazine

ANGIER CORPORATION
CORROSION PREVENTIVE AND WATERPROOF PAPERS
FRAMINGHAM, MASSACHUSETTS

Angier

Scott

TAIL WHEEL ASSEMBLY

STEERABLE — FULL SWIVEL

MODEL 3-24B

Builders of light airplanes seeking a service-tested tail wheel assembly will be interested in these features of the CAA-approved Scott Model 3-24B. Simplified automatic mechanism: Needle swivel bearings: Heavy-duty bracket: Positive action arm assembly: Drop forged single arm fork: High-strength aluminum alloy wheel castings: Timken grease-packed roller bearings: Felt grease seals: Tight dust caps. Complete data on request.

SPECIFY AS "Standard"

Scott AVIATION CORPORATION

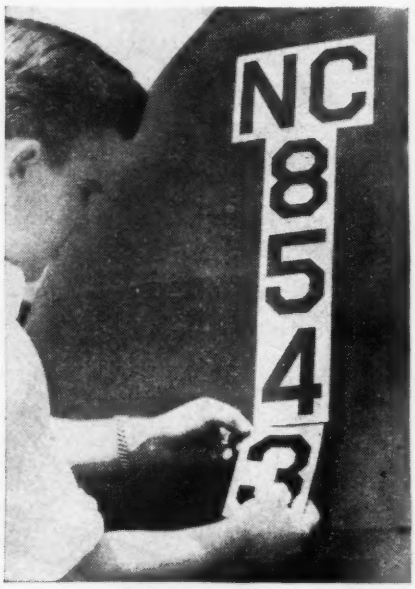
214 ERIE ST. LANCASTER, N. Y. U. S. A.

ESTABLISHED 1932

ment Co., Los Angeles. On one piece welded chassis are mounted tanks varying in cap. from 50 to 300 gal., with all fire prevention factors incorporated. Demountable self-contained pump, meter, and manifold unit, complete with suction and discharge pipe, also hose assemblies equipped with interchangeable gasoline engine, electric motor, or hand operated pump, are all mounted on steel base and fit standard trailer.—**AVIATION, Oct., '45.**

NC Numbers Stencils.....112

Paper stencils, enabling placing of NC numbers on both sides of tail fin, including spraying of two coats of color, in less than one hour, are announced by **E. W.**



Wiggins Airways, Norwood, Mass. No measuring is necessary, and connecting links of ordinary stencil are absent. Photo shows mechanic applying stencils prior to painting.—**AVIATION, Oct., '45.**

Case Against Integration

(*Continued from page* 185)

"integration" then. In fact, for many years rail carriers were free to, and did, indulge in secret rebating, discriminatory rates, and other methods of competition. But air transport, at the beginning of its greatest development, has been subject to the highest standards of conduct and the strictest regulation for the protection both of competitors and of the public. Air transport will never be free to assume the role of a buccaneer.

Nothing has happened, since the consideration and adoption of the Civil Aeronautics Act, to furnish any argument today which was not known and appreciated at the time of its passage, when Congress very definitely separated the regulation of all aspects of air transportation from that of other carriers. All the facts existing now existed then, except that now the railroads are better off than they were then.

Congress debated the question and decided that regulation of air carriers, with the rest of civil aviation, should be placed all in one spot and coordinated under a new agency. Congress

specifically rejected, at that time, a proposal to place air-carrier regulation under the ICC. This decision was not hastily taken. It followed years of study, and the result of this study should not now be overturned. As Representative Lea said in the debates on the Civil Aeronautics Act of 1938, "No other agency of the Government has a set-up so well qualified for aviation regulation as the independent body this bill would create."

The issue now is whether the principle that aviation is a special problem requiring special treatment shall be adhered to by Congress, or whether the hard-won gains of years of struggle and of study shall be swept away in the effort to solve the problems of older modes of transport. It has been urged that "to vest the ICC with the regulation of air transport would be a step toward coordinated regulation of all transportation." But if we are going to "coordinate," if we are going to "integrate," if we want to settle difficulties of transportation largely through regulation, we must be bold enough to realize the fact that we must assign to each competitive agency that class of transportation which it can carry on to the greatest economic advantage and, perhaps, exclude the one less qualified to perform the service.

We have to be bold and brave enough to do that, if we are going to meet our problem through regulation and really "coordinate" or "integrate" transportation. Certainly air transport is not yet ready for such bold judgment on the part of a federal agency. We can reach that judgment only when we are fully prepared to say just what the destiny of transport by air shall be. If we attempt to do so too soon we run the grave risk of denying to future generations a heritage which other countries are diligently providing for theirs, and of defying the forces of progress and inventive genius which have made this country great.

Air transportation, because of its nearly pioneer character, is not ready for anyone to determine the field from which it shall be excluded. Nor is it ready for anyone to delineate the field in which it shall operate.

Mastery of the nature of air transportation, its problems, and its possibilities, is a full-time undertaking, and in several respects any proposal to place all or part of the regulation of this industry in the hands of such an agency as the ICC would risk serious harm to the industry and to our national policy.

1. It would, unless *all* aspects of aviation regulation were included under the one agency (and no one has suggested going quite this far), divide control and create conflicting jurisdiction. We would have two agencies of the Government regulating the same thing in many cases.

2. It would vest the ICC with powers requiring a knowledge of air transportation which that body does not now have and which would require some time and much money to obtain.

3. It would require determinations, regarding the future place of air transportation in our economy, which neither the Government nor the industry is yet able or ready to make.

Commercial air transportation, above all, should not be crippled by retreating from the principle of unified and coordinated regulation by its own governmental agency. Certainly there can be no value in sacrificing this industry in the interests of "integration" or in academically making complete the regulatory authority of the ICC.

Radical Blackburn Hull

(*Continued from page* 176)

the center section, the front and rear spars had extruded lipped angle booms

New Keyless Chuck
does its own drill tightening
THE TURNER CHUCK Saves Time!
Hardened bearing steel roller jaws grip the drill without chewing or scoring.
Grip is automatically and progressively strengthened with increased load pressure
Ball bearings increase life.
Absolutely KEYLESS. No more chewed drill shanks. No more time wasted looking for keys.
The Turner Chuck is self-energizing. Tightens itself by the action of the drill.
Drill will not slip in use. Chuck is automatically self-centering and drill runs true without hand adjustments.
SPEED RECONVERSION
Write Now!
TURNER BROTHERS
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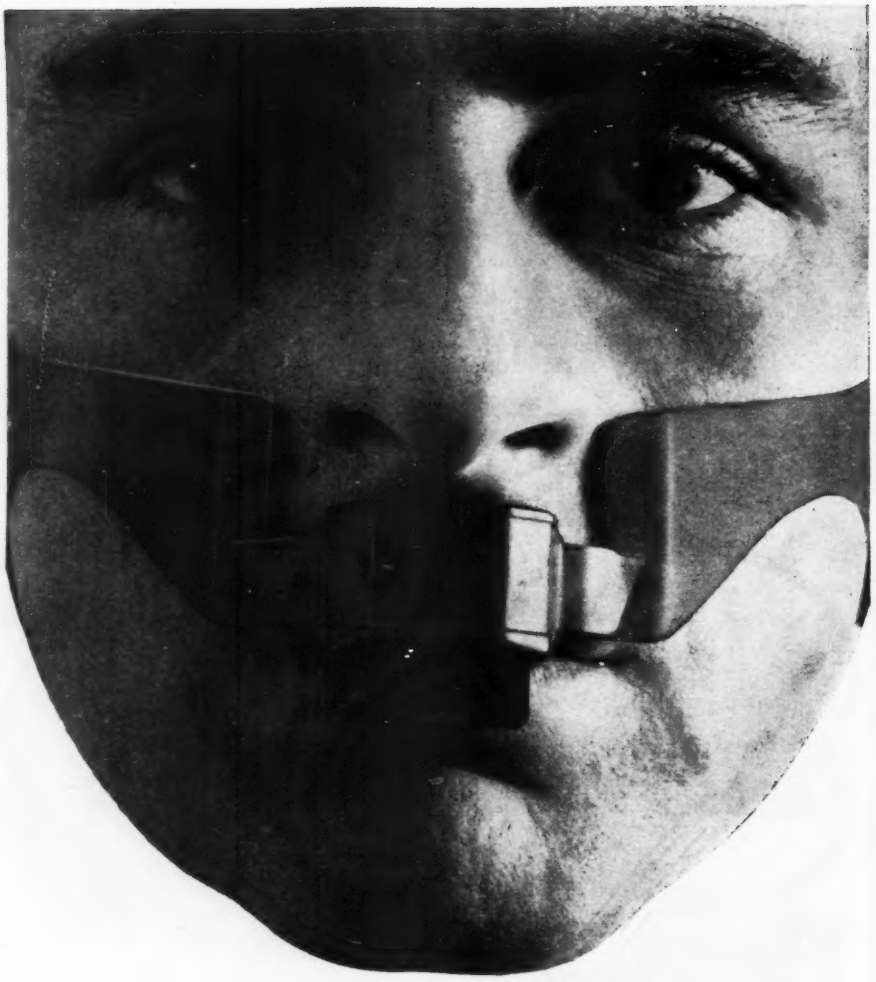

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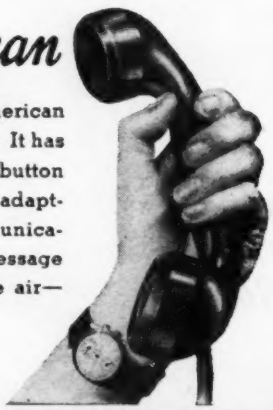
GIVE THE TOWER A BREAK!

The American Lip Microphone weighing only 1½ ounces will fully modulate any transmitter having a standard single button carbon microphone input. Ideal for cabin planes. Cuts out ambient noise. Feeds clear articulate signals to the set. Leaves hands free for flying. Not affected by barometric pressure. As easy to put on as eye-glasses.

talk American

The compact utility of an American Hand Set is well established. It has a microphone-relay push button switchcontrol and is readily adaptable to various voice communication circuits. To get your message thru on land, at sea or in the air—Talk American!



Bulletins Available—
Jobbers or Home Office

American MICROPHONE CO.
1915 So. Western Avenue, Los Angeles 7, California

and single webs of Alclad sheet, the webs being stiffened by vertical members of that section. The middle spar was a braced girder built up from drawn sections. In the outer wings all three spars were of similar construction, with extruded bulb angle and plate webs suitably stiffened.

Ribs had solid sheet webs with vertical stiffeners, and they were slotted to accommodate tubular stringers, to which they were attached by pressed collars. The wing was covered throughout by Alclad sheet. Riveting was flush, all exposed joints in the skin being joggled or butted. Flush riveting was achieved by dimpling. Between the front and rear spars throughout, and in the leading edge outboard of the engines, the skin was supported on tubular stringers. The leading edge between the engines and hull was detachable (for access to fuel lines, engine controls, etc), the stringers of this portion being of "Z" form. The three main spars, top skin, and stringers were continuous across the hull. Front and rear spars were attached to specially strengthened frames in the hull.

Beneath the wing, pockets were provided to accommodate the wing float struts when the floats were retracted. Ailerons were of normal construction with fabric covering. Flaps were metal-covered, and each was supported on two curved tracks and operated by a push rod. These push rods were coupled to a layshaft which was operated by hydraulic jacks and arranged to synchronize the movement of the flaps.

Constructed in one piece, the tail plane was built on two spars. It was attached to the hull at specially strengthened frames. The balanced e' - vators were built in two halves, which were coupled by torque tubes through the hull. Elevators were fabric covered and fitted with trim tabs.

A crew of four was carried, and provided were sleeping quarters, galley, and engineer's bench fitted with tools. Owing to the craft's experimental nature, no armament was fitted, but provision was made for inclusion of power turrets.

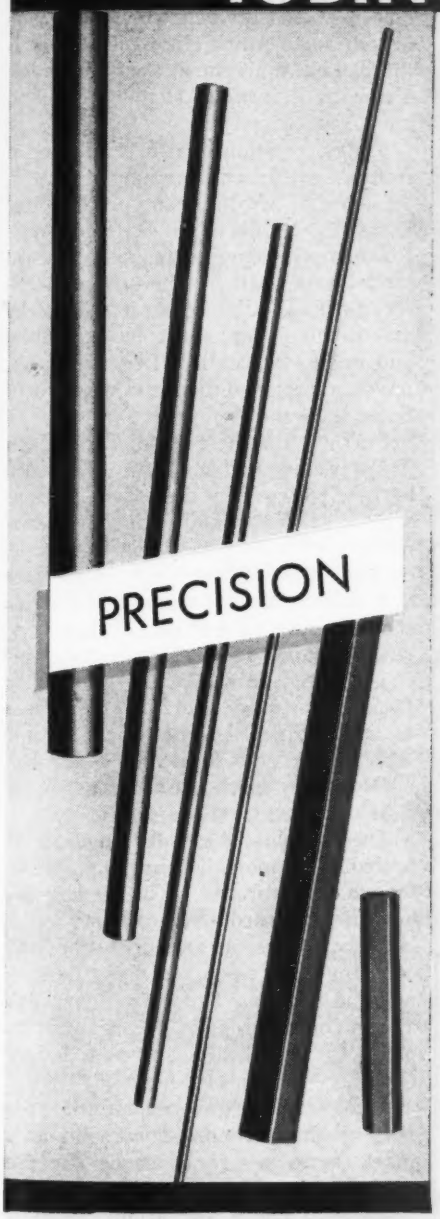
Estimated performance without armament was as follows: Top speed, 280 mph., at sea level; 302 mph. at 5,570 ft.; and 306 mph. at 15,000 ft.

With mid-upper and tail turrets mounted, the following top speeds were estimated: 268 mph. at sea level; 302 mph. at 5,570 ft.; and 306 mph. at 15,000 feet. Cruising at 200 mph., range was put at 1,500 mi.

It is stated that the Blackburn B-20 performed very satisfactorily both on the water and in the air, the retractable hull bottom operating successfully. Work on the prototype was unfortun-

AGALOY

TUBING · TUBULAR FORMS



PLANNING new equipment? Consider performance records of **AGALOY** tubing in hundreds of applications.

Made in stainless, low carbon, high carbon, alloys and Monel metal. Also bimetal in any combination of metals. In *welded, seamless* or *spiral brazed* construction.

Sizes to ⅜-inch outside diameter.

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DESIGNING or redesigning parts? New low-cost method originated by **AGALOY** coils a variety of metals into tubular forms.

Outside diameter to four inches; length to 22 feet; thickness to 16 gauge.

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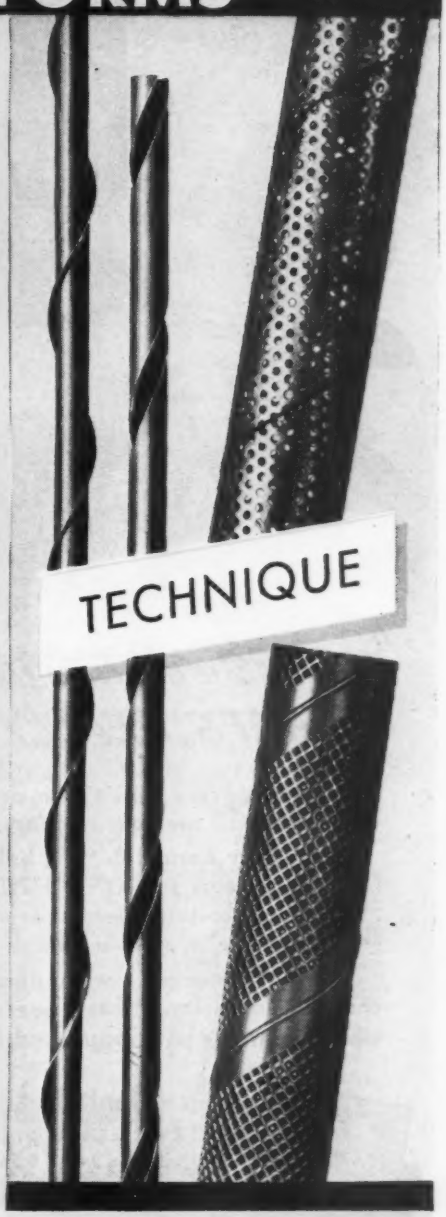
Write for detailed information to



AGALOY TUBING COMPANY

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"HERE'S AN EXTINGUISHER THAT'S REALLY PANIC-PROOF!"

Safety engineers don't use extinguishers. Actually, it's *the employees* who are your real fire-fighters.

That's why Randolph "4", lightweight and easy to use, is *ideal* for the amateur. Just ONE HAND snaps this unit from its bracket . . . one trigger-touch sends carbon dioxide gas deep into the blaze —kills the fire in *split-seconds!*

A dry, odorless gas, carbon dioxide cannot damage equipment or conduct electricity. It leaves no stain or mess . . . actually disappears when the fire is out! *Approved by Underwriters' Laboratories.*

Randolph SIMPLIFIES FIRE-FIGHTING

FREE! Send me your new, 16-page booklet "Sharpshooting at Flames." Illustrates how to fight fires and protect property with fast-action carbon dioxide gas.

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ately brought to an end by an accident, and although a second design had been begun embodying similar features to the B-20), further work had to be postponed since wartime demands absorbed all available design and factory capacity. Nevertheless, it is said that the Blackburn company still considers the project a sound one, and further developments may mature later.

Don't Sell Industry Short

(*Continued from page* 107)

on a new model which, for some reason or other, does not click. But this is the gamble inherent in the aircraft industry at its present stage of development.

Today the industry is in the throes of contract settlement, a winding-up process that is working out much better than was thought possible 18 mo. ago. Fortunately, many companies switched earlier this year from cost-plus-fixed-fee to fixed-price contracts, thereby making final settlement more definite and easier to handle. In some cases, pre-termination settlements were negotiated with the Army and Navy.

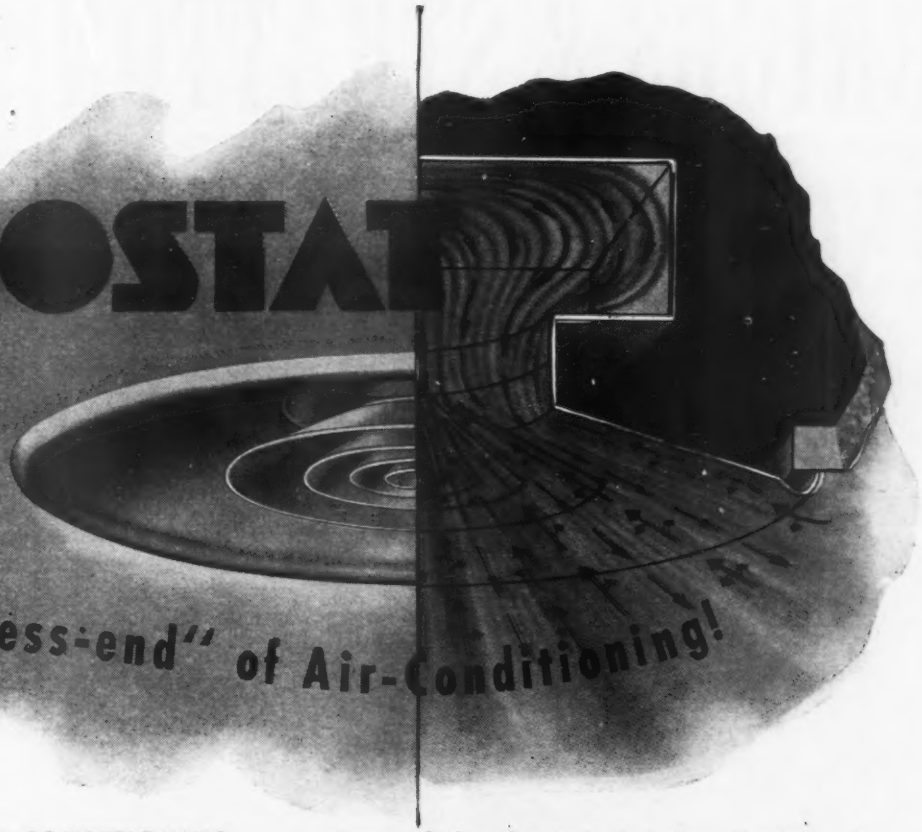
Furthermore the government and the industry have had sufficient experience by now to wind up the job of settling around $35,000,000,000 in newly terminated contracts. Readjustment officials estimate that, if war contractors submit their claims promptly, contracts can be settled in 4-6 mo. Some of the larger and more difficult ones, they concede, may take 6-12 mo. The War Department now has 12,000 employees assigned to settlement work against 4,100 a year ago, while the Navy has 3,600 people on the task against 1,200 a year ago.

The surplus disposal situation is probably the most discouraging spot in the whole picture, as far as the government is concerned. Due to faulty legislation, cumbersome administration, and constant changes in top-flight personnel, the Surplus Property Board has almost come a cropper. Reorganization plans for the board are now before Congress—at the 11th hour.

Aside from the government angle the surplus disposal problem will be a much more severe headache for the engine makers than for the rest of the industry. There are around 800,000 surplus aircraft power plants, thousands of which lie unpacked at depots all over the world.

With an estimated 11,000 planes and 800,000 engines on its hands, the government has the choice of scrapping most of these goods or directing their sale in competition with industry. However, no matter what the solution, the situation isn't as bad as it was after the last war, due to the rapid

ANEMOSTAT



. . . the "business-end" of Air-Conditioning!

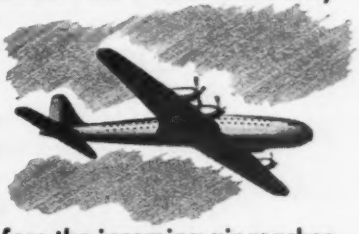
"NO VENTILATING OR AIR-CONDITIONING SYSTEM IS BETTER THAN ITS AIR DISTRIBUTION".

When large volumes of ventilating air are forced into a plane cabin, drafts occur—unless ANEMOSTATS are used. The patented ANEMOSTAT is an air-diffusing device without moving parts. It is easily installed on any aircraft ventilating or hot-air heating system. It assures draftless distribution of any volume of cooled or heated air at any velocity.

During the last 25 years, more than 50,000 installations throughout the world have proven that *efficient* air-distribution is synonymous with ANEMOSTAT—the "business-end" of air-conditioning . . . and *ventilating!*

HERE IS HOW IT WORKS

The ANEMOSTAT diffuser creates a series of air currents flowing away from the device in planes or blankets at scientifically correct angles. In addition, the ANEMOSTAT creates a series of counter-currents of cabin-air which are siphoned into the diffuser and mixed with the incoming air streams. Thus, 35% of cabin-air is pre-mixed with the incoming cooled or heated air before the latter is discharged into the cabin. This action is the only true *"Aspiration"*— *and it is exclusive with ANEMOSTAT!*



This air-mixing action *within* the ANEMOSTAT establishes the required cabin temperature before the incoming air reaches the passengers—so no blasts of cold or hot air are encountered by the occupants. Higher temperature differentials are thereby possible . . . resulting in smaller volumes of air requiring conditioning.

Higher air-velocities may be employed with the ANEMOSTAT because of its draftless diffusion, so smaller ducts and simplification of duct layouts naturally follow. Yes, ANEMOSTAT is the "business-end" of air-conditioning—*and ventilating!*

•

***Write today for Bulletin which gives you full details.* There's no obligation!**

AC-1009

Veteran-ize your personnel!
Many discharged war veterans received valuable technical and specialized training. Always consider veterans when you employ. They did their share—now let's all do ours!

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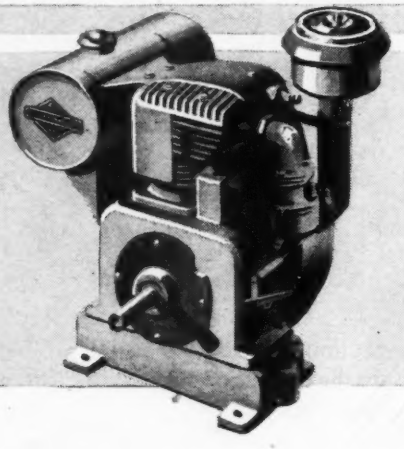
THERE IS AN ANEMOSTAT DESIGNED FOR EVERY AIRCRAFT APPLICATION

BRIGGS & STRATTON ENGINES NOW ON THEIR WAY BACK TO YOU!



BACKED by an outstanding record of valiant service in scores of standard and special wartime applications, Briggs & Stratton 4-cycle gasoline engines have returned to peacetime activities. With greatly expanded facilities for precision manufacture, we are now producing more and more quick-starting, dependable, trouble-free, Briggs & Stratton gasoline engines in a full range of sizes and models — recognized the world over as the preferred "air-cooled power".

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Air-Cooled Power

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

changes taking place these days in aircraft development.

Aircraft stocks seem to have discounted the industry's transitional period. That is, they have if the rest of the market has fully discounted the tremendous conversion of the American economy from a war to a peacetime basis. In other words, aircraft stocks should follow the general market trend for the next few months.

Hughes H-4 Nears Takeoff

(*Continued from page* 175)

the glue had cured. Approximately 8 tons of these nails were used, and special nailing guns and nail pullers were developed by the company.

Exterior finish consists of one coat of wood filler, one coat of sealer which acts as a cement for the thin tissue paper placed over it, two coats of spar varnish, and one coat of aluminized spar varnish.

Engine Installations

Minor repairs and adjustments to the engines will be possible during flight, since accessibility is provided by a passageway ahead of the front spar. Nacelle structures, which are all-wood, are mounted to the front spar by steel tube adapters.

A small oil tank is located in each nacelle and may be refilled at any time from a central oil reservoir by means of a semi-automatic control system. Two transfer pumps supply fuel from the hull tanks to a service tank in each wing. A complete and separate emergency system will provide enough fuel to all engines for maximum power at required pressure at the carburetor. An interesting feature of the system is that fuel lines range in size from 1 in. to 3 in. dia.

Control Systems

Control of the engines will be expedited through use of Pneudynes, compressed air transmitting devices long used by railroads for brake control. Any position of the lever on the transmitting Pneudyne will accurately be held on the receiving Pneudyne for indefinite periods, even during atmospheric and temperature pressure changes. The pneumatic system is completely enclosed, requires but a small amount of makeup air, and has moisture absorbing devices to safeguard against freezing.

A hydraulic telecontrol system will transmit the pilot's actuations, with operating power supplied by electrically driven hydraulic pumps which provide oil to sensitive relay valves operated by the pilot. This system will not only work the controls, but being reversible,

it will also signal gust forces to the pilot.

Pilot's and co-pilot's flight controls are of the conventional type, except that the rudder pedals have a motion parallel to the floor, as in a rudder bar. Trim tabs are to be electrically operated (through toggle switches) and fitted with electric linear actuators.

Design proposals were submitted to the government in the summer of 1942 and later, when Henry J. Kaiser entered the picture, an $18,000,000 contract for three of the planes was awarded the Kaiser-Hughes Corp., calling for delivery of the first craft in Dec. 1943, the second and third in Mar. 1943 and Oct. 1943, respectively. Mr. Kaiser "retired from the project" early last year, arriving at the conclusion that mass production of the craft was impractical. Hughes Aircraft Co., which originally started the project, has continued alone since that time.

Review of Patents

(*Continued from page* 201)

make it necessary for trainee pilot to reset directional gyro compass approximately every 15 min., as required in actual craft.—2,379,869, filed Aug. 6, '43, pat. July 10, '45, C. I. Baker, assignor to Bell Telephone Laboratories, Inc.

Aircraft Design, providing for laterally extending rotor-like auxiliary wing disposed beneath each main wing, and having auxiliary wing center located on horizontal axis through craft's center of gravity, is intended to improve stability and increase ease of maneuverability.—2,379,875, filed Sept. 14, '43, pat. July 10, '45, O. W. Boyea.

Airplane Landing Apparatus for roof tops, floating seadromes, and vessels comprises special movable platform. Braking hook on plane engages bail connected to platform, thus causing latter to move forward carrying plane. Bail is pulled forward to effect actuation of resilient shoes against walls to bring platform carriage to a stop.—2,380,105, filed Mar. 11, '44, pat. July 10, '45, O. Gerrard.

Engine Mounting for inline engines is arranged on aircraft to afford oscillatory support at opposite ends of engine along axis of oscillation extending through center of propeller hub, center of mass of engine, and through center of front and rear mountings. Hydraulic means, controlled by engine speed, limit torque oscillation.—2,380,274, filed Nov. 4, '40, pat. July 10, '45, R. S. Trott.

Cargo Craft, with Burnelli-type airfoil-fuselage all-wing structure, is designed for transporting fuel and oil. Lifting fuselage acts as receptacle for molded plastic-plywood containers arranged laterally and suspended from fuselage wing beams, and hoisting means are provided for loading and unloading.—2,380,290, filed Sept. 6, '41, pat. July 10, '45, V. J. Burnelli, assignor to V. J. Burnelli Airplanes.

Landing Wheel Control, incorporating spinning device which rotates wheels at speed commensurate with landing speed and automatically controls rotation without attention by pilot, also includes braking mechanism which eliminates high pressure fluid lines of conventional hydraulic brakes.—2,381,842, filed Sept. 16, '43, pat. Aug. 7, '45, F. N. Schwend.

Rotary Blade System is designed to permit pilot to select desired ratio of lifting power to the translatory power without changing total thrust of rotary system. Included are means which tend to cause increase of lifting power when translatory speed is increased, or at least a decrease of lifting power at lower rate than occurs with absence of such means.—2,381,968, filed Apr. 1, '43, pat. Aug. 14, '45, E. W. Bossi.

Braking Apparatus integral with wing structure and designed for rapidly varying speed of plane in flight without change in engine or propeller speed, operates by varying inflow and outflow of air through a confined space. Conduits are provided which extend substantially parallel with fuselage and have entrance and exit openings controlled by doors.—2,382,016, filed Aug. 16, '41, pat. Aug. 14, '45, A. Love, assignor of one-fourth to E. J. Garity.

Heating System for aircraft incorporates internal combustion type heater with combustible mixture provided by independent carburetor or withdrawn from fuel mixture supplied by engine supercharger depending upon whether pressure generated by supercharger exceeds atmospheric pressure.—2,382,493, filed June 12, '42, pat. Aug. 14, '45, H. J. De N. McCollum.

Beating the Fire Hazard

(*Continued from page* 184)

ions, permitting conduction of electricity. As flame passes between the two conductors, current flows in the detector circuit and actuates a relay. This type is obviously large, and space limitations will often prohibit location of such units in the probable flame paths.

The shortcomings of heat and flame detectors have invited development of smoke detectors. Such units are appearing on the market for untenanted spaces. One type uses a photoelectric cell with the beam of light transmitted axially down the tube. The tube is arranged so that it is the air outlet portion of the compartment's ventilation system. Smoke passing through the tube interrupts the beam and causes a variation in current output, which is made to indicate via any type device desired. A similar size sealed tube is used with a balancing circuit to compensate for variations in voltage input, such as when the plane's batteries are low in voltage.

Fire Extinguishing

The principles of fire extinguishment, naturally dictated by the requirements of combustion, are defined as follows:

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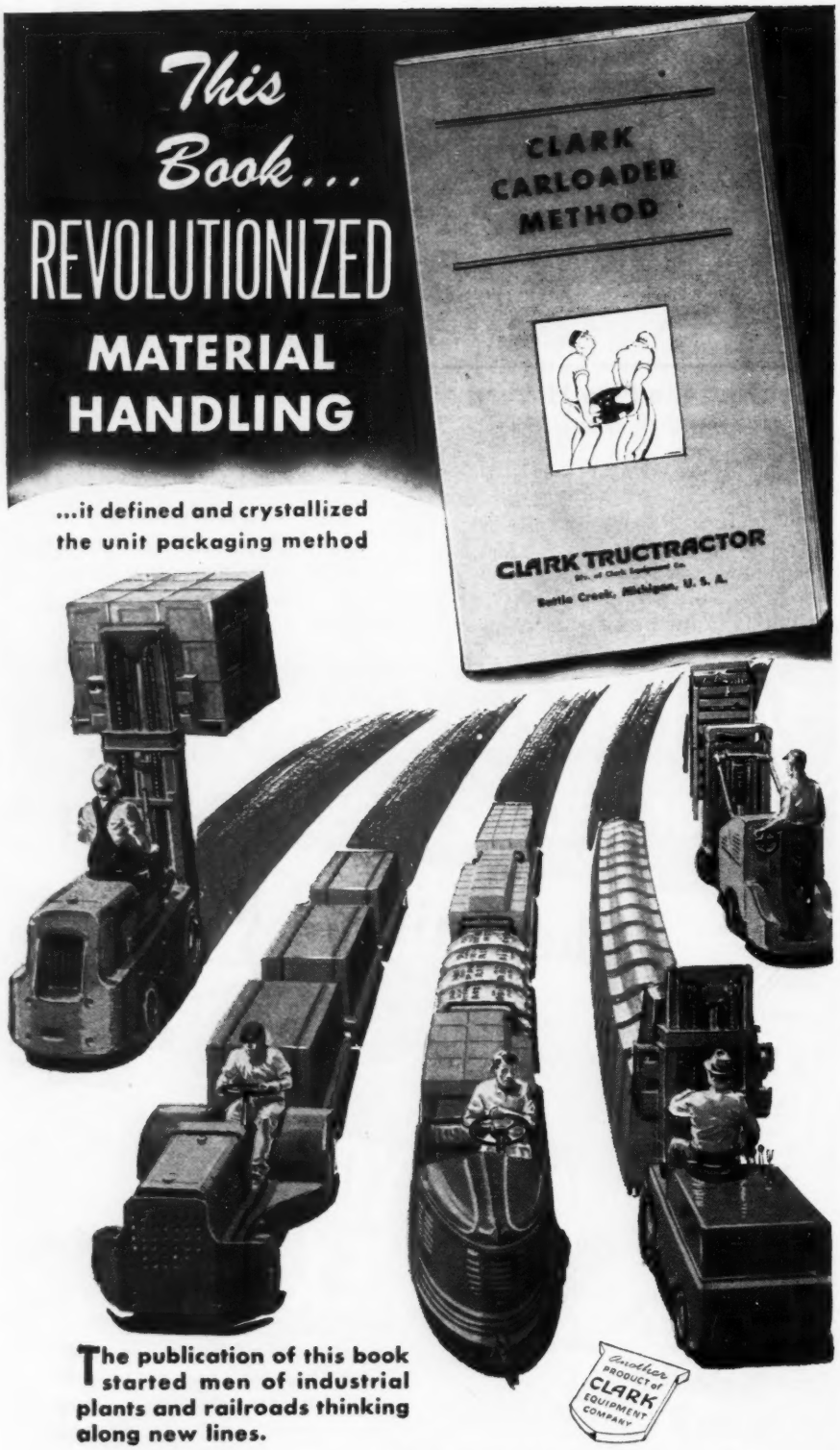

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1. Exclude oxygen from the seat of the flame (known as "blanketing"), or dilute the oxygen with an inert gas so that the mixture will no longer support combustion (known as "smothering").

2. Cool the material to a temperature below the ignition point and maintain this cooling for sufficient time to prevent re-ignition.

3. Blow out the fire, such as in the extinguishment of a match, a candle, or other devices such as those having wicks.

It is to be noted that a few substances, such as solid nitrocellulose in the form of gunpowder or dry film, release free oxygen when once ignited and therefore do not respond to the first principle. Such materials cannot be extinguished with carbon dioxide or even by submerging under water. Use of the second principle is self-explanatory; and the third is effective because the passage of air physically removes the flame faster than it can propagate and thereby removes the self-propellant source of ignition and cools the material to a point below the ignition point.

Extinguishing Agents

The two most common types of fire extinguishing agents used in aircraft are carbon dioxide and carbon tetrachloride. As for the CO_2, this is usually provided in the airplane via a piped installation for engine protections and in portable form for passenger cabin and crew quarters. Carbon tetrachloride is supplied in the form of 1-qt. hand extinguishers for cabin and crew quarters.

The salient feature of CO_2 is its smothering effect—i.e., its ability to dilute the atmosphere to a point where it will not support combustion. This is accomplished in a matter of seconds by its natural expansion to a gas, which is of course three dimensional in its extinguishing effect, penetrating crevices not accessible to surface blanketing. Under such conditions, some slight benefit is also obtained from the cooling effect of the gas, which is usually colder than —100 deg. F. when emitted from the extinguisher. However, both these effects are reduced when CO_2 is used in open air, due to dissipation of the gas by air currents.

On contact with flame, carbon tetrachloride generates approximately 2.5 cu. ft. of gas mixture per pound of liquid, or approximately 8.25 cu. ft. of gas mixture per quart of liquid. The CCL_4 gas is approximately 5.3 times as heavy as air. On contact with flame, the mixture consists largely of carbon dioxide, with several other gases being generated in lesser quantities. These gases act as a smothering agent and

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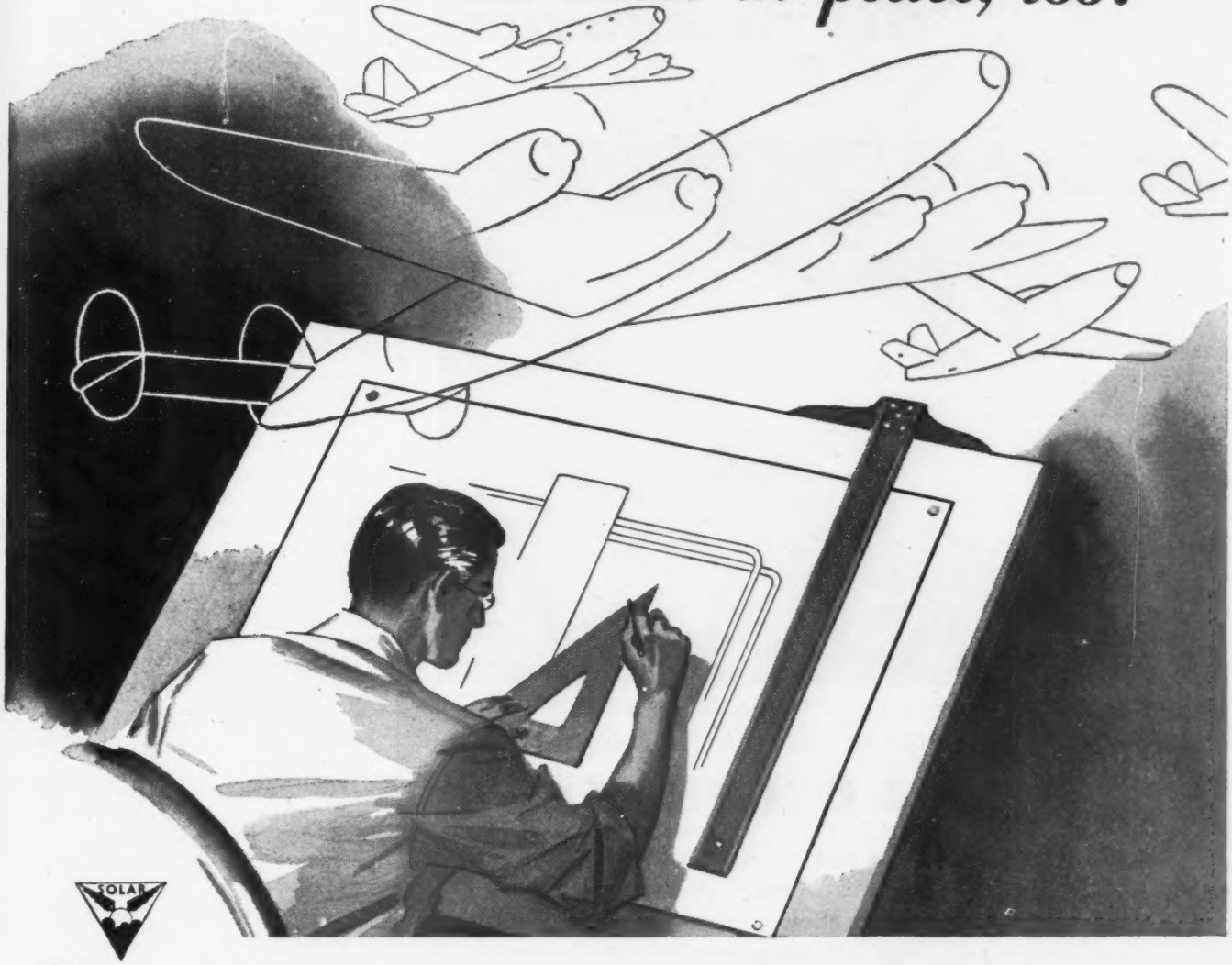

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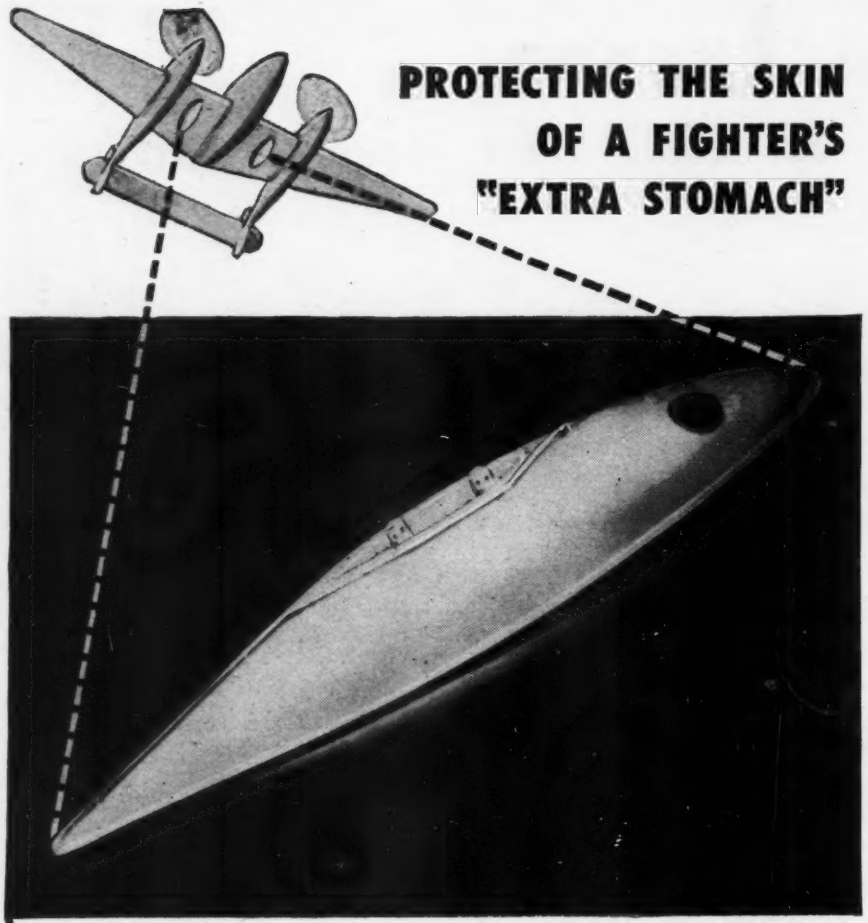

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their effectiveness is somewhat enhanced by the fact that they are relatively heavy.

Among the extraneous gases generated under combustion is phosgene, which is extremely harmful if breathed in even minute concentrations. A life hazard is therefore attendant to the use of this type of extinguisher in *unventilated* areas. There are a number of variables which affect the degree of hazard, but it is generally agreed that concentrations of 2.5% of CCL_4 vapor by volume or less is not lethal for durations of exposures up to 30 min. under no-ventilation condition.

Liquid carbon tetrachloride will freeze at approximately —8 deg. F., therefore it must be protected from low temperature. It is a non-conductor of electricity and may be safely used on electrical fires.

Methyl bromide has often been considered to replace CO_2, since it is about 3.3 times as heavy as air and therefore tends to be more effective as a blanketing agent. Methyl bromide produces less gas per pound of liquid than does CO_2—the volume being some 4 cu. ft. of gas per pound against 8 cu. ft. per pound of liquid CO_2. On the other hand, methyl bromide is heavier in weight but liquefies at much lower pressures. This means lighter weight cylinders and, despite the heavier liquid, permits an appreciable weight saving. Methyl bromide also does not freeze above approximately —135 deg. F.

The disadvantage is that methyl bromide generates such gases as hydrobromic acid, bromophosgene, and free bromide, all of which are toxic. Concentrations should not exceed 0.7% by volume in unventilated areas for personnel safety. For this reason, methyl bromide is not likely to meet general acceptance as a replacement of CO_2, which is not toxic, except possibly for power plant use.

For building use and for ground fighting of airplane fires, the most common extinguishing agents are water, foam, and CO_2. Water in the liquid state has a tremendous cooling effect and the steam produced contributes materially because of its blanketing effect. Water in emulsified form similar to fog is rapidly being accepted because of its diluting and cooling abilities.

Design Considerations

As previously noted, the principle of operation of the type of extinguishing agents used in piped installations is the dilution of the atmosphere surrounding the fire with an inert gas to the extent that the atmosphere will not support combustion. In most aircraft fires, this atmosphere is the slipstream, or some such rapidly changing air mass and, therefore, practical considerations introduce a time element into the dilu-

tion procedure and defines effective dilution as that which will arrest and prevent combustion for a given minimum duration. Tests conducted by the Civil Aeronautics Authority indicate that this minimum duration is 2 sec.

It can therefore be said that *the rate of application should be one-half of the total quantity per second.* This rate of application is most important and should not be altered, even with changes in quantity of agent. With the proportional rate and duration established, the total quantity becomes a function of airflow and it is therefore convenient to divide the hazards into the following zones:

Zone 1: Potential fire areas through which flow great quantities of air past systematic arrangements of identical obstructions, such as engine cylinders. These locations should be protected by systems which provide equal distribution of the extinguishing agent across the airflow. The engine proper is the most important example of this zone.

$$\text{Quantity of } CO_2 \text{ (lb.)} = \frac{.035 = (\text{lb. air through zone in 2 sec.}) \times \text{No. of engine cylinders}}{14}$$

$$\text{Quantity of Methyl Bromide (lb.)} = \frac{.028 \times (\text{lb. air through zone in 2 sec.}) \times \text{No. of engine cylinders}}{14}$$

The total nozzle outlet area should be 0.11 sq. in. per pound of agent discharged. The nozzle feed lines should have a cross sectional area of 110 to 125% of the nozzle feed lines.

Zone 2: Potential fire areas through which flow great quantities of air but which are clean aerodynamically. Such locations should be protected by an arrangement of nozzles or perforated tubing which will discharge extinguishing agent between the air inlet. This zone includes such locations as the area between the tailpipe and shroud in many designs, the oil cooler and scoop, induction system ducting, and ducting to such units as internal combustion type heaters.

Quantity of Carbon Dioxide (lb.) = 0.25 × (lb. air through zone in 2 sec.)

Quantity of Methyl Bromide (lb.) = 0.20 × (lb. air through zone in 2 sec.)

Nozzle areas and line sizes are the same as for Zone 1.

Zone 3: Potential fire areas which are subject to low airflow rates in comparison with the volume of the zone. These zones do not require equality of agent distribution but do require reasonable distribution at an agent discharge rate sufficient to flood the zone. Zone 3 includes such areas as engine accessory compartment, internal combustion heater compartment, and possible nacelle or wing compartments.

Quantity of Carbon Dioxide (lb.) = 0.20 × zone volume (cu. ft.)

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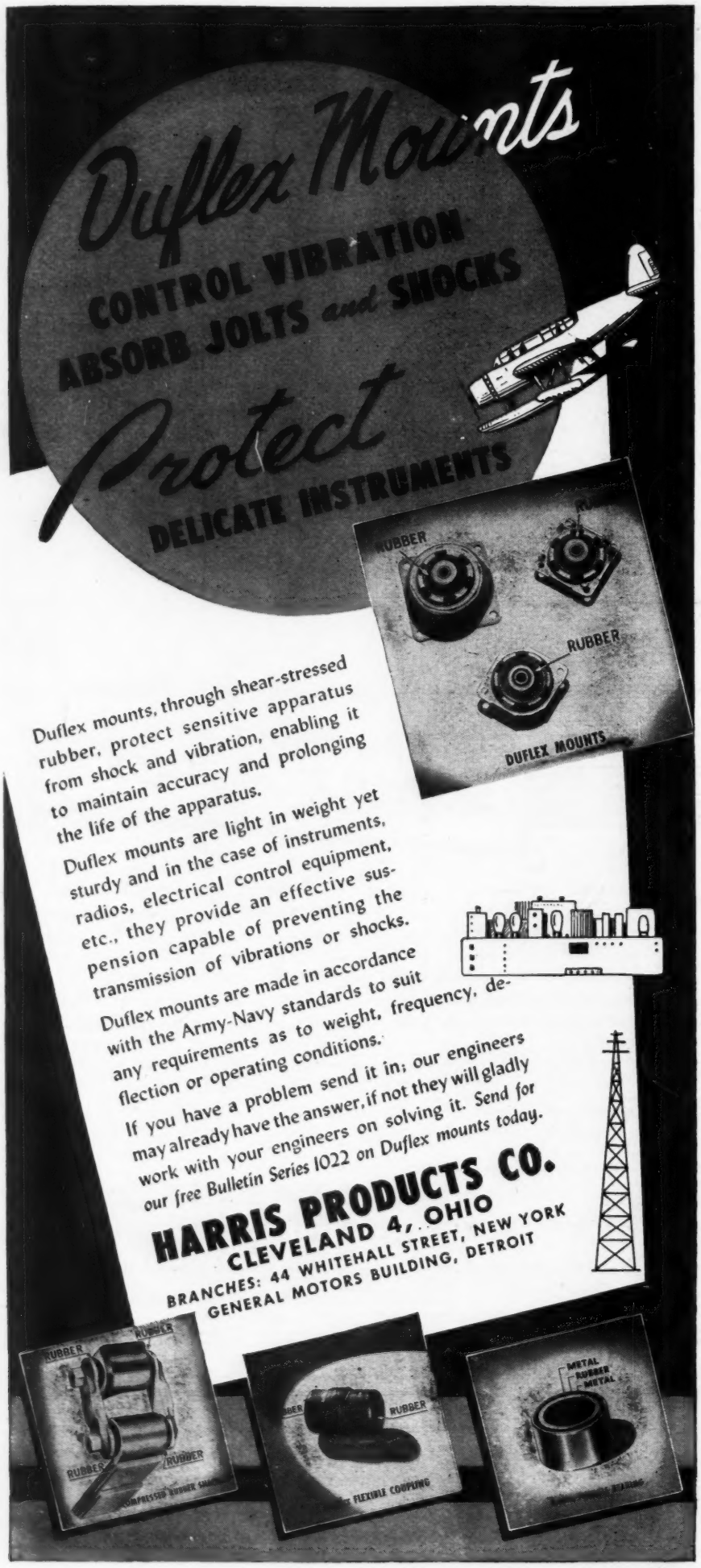
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Quantity of Methyl Bromide (lb.) = 0.16 × zone volume (cu. ft.)

The total area of the outlets should be 0.07 sq. in. per pound per second. The cross section area of the feed ring should be 100 to 110% of the total outlet area, and the main feed lines should have an area of 100 to 110% of the feed ring area.

Zone 4: Potential fire zones through which no air flows. These do not require equal agent distribution but do require sufficient agent to flood the zone. Such zones might include hydraulic compartments, inaccessible fuselage and wing compartments, and tank areas.

Quantity of CO_2 (lb.) = 0.14 × zone volume (cu. ft.)

Quantity of Methyl Bromide (lb.) = 0.11 × zone volume (cu. ft.)

The outlet and line areas are the same as for Zone 3.

The majority of the design data just quoted is from CAA Technical Development Note No. 31, titled *Design Recommendations for Fire Protection of Aircraft Power-Plant Installations*, dated Sept. 1943. Additional data is available in this report.

New Douglas Transports

(*Continued from page* 110)

by airline and military passenger and cargo planes which preceded it into the air. At 145,000 lb. gross, the craft is designed to clear a 50-ft. obstacle in less than 3,500 ft. and land at 92 mph. in less than 2,750 ft.

Introduced shortly after was the DC-8, a radical design, 38–48 passenger commercial craft featuring twin V-1710 Allison engines set in the fuselage driving, via 60-ft. shafts, contra-rotating propellers set aft of the empennage.

Engines are located beneath the pilots' "double bubble" cockpit, accessible via bombbay type doors to facilitate service, with the shafts extending aft under the passenger cabin then up through universal joints to a gear box at the fuselage tail cone.

Main cabin has a movable bulkhead whereby, within about 20 min., cargo-passenger capacity can be varied, thus assuring maximum possible payload. Optional cabin arrangements are also offered to take care of varying airline needs, some of which are designed to decrease ground crew sizes. One such modification, for example, is a combination built-in door and step, another is an additional door set forward of the wing.

Removal of engine nacelles and propellers from the wings permits installation of shorter and narrower-tread landing gear, as well as lighter structure.